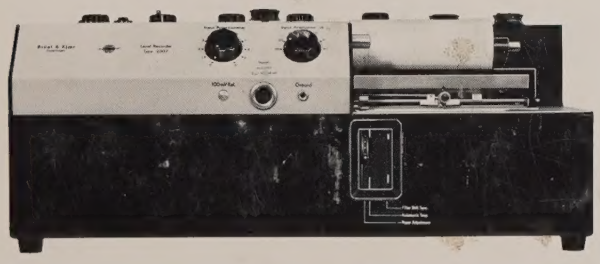
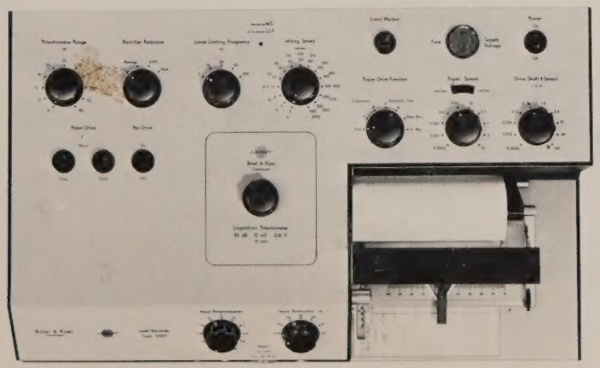
2307

Instruction Manual

Level Recorder Type 2307





D/374

W. F. Wood

A precision, mains powered instrument designed for fast, accurate graphic recording of AC and DC signals levels from 5 mV to 100 V with frequencies up to 200 kHz. It is equipped with DC, Average, RMS and Peak response modes and accepts two linear and 4 logarithmic interchangeable Range Potentiometers giving a choice of six dynamic ranges. Writing widths of 50 and 100 mm may be selected for recording on rectilinear and polar charts. Levels may be recorded in ink or as a finely scribed line on wax paper. Full remote control facilities for synchronous tuning of B & K Frequency Analyzers and Signal Generators permit automatic recording of frequency analyses and responses etc.

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LEVEL RECORDER
TYPE 2307

D/374

W. F. Wood

Revision March 1980

This apparatus has been designed and tested according to Class I of IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The present Instruction Manual contains information and warnings which should be followed by the user to ensure safe operation and to retain the apparatus in safe condition.

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type 2307

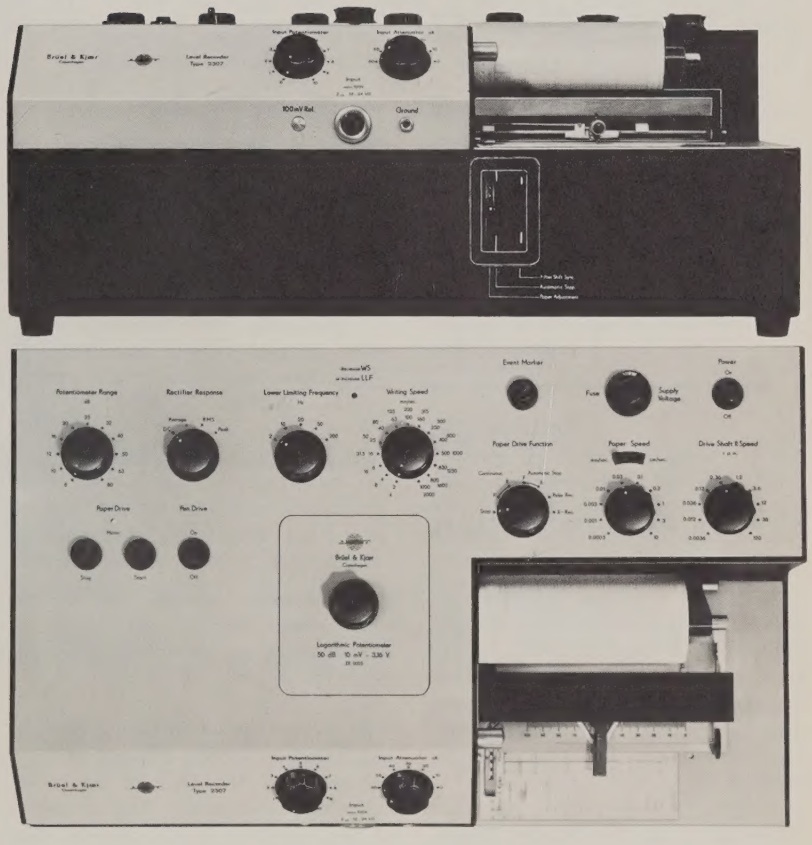
Graphic Level Recorder

FEATURES:

- 2 linear, 4 logarithmic dynamic ranges
- AC and DC recording
- 12 fixed paper speeds
- 2 chart widths
- Rectilinear or polar plots
- RMS, Average, or Peak detection
- Versatile synchronization and remote control facilities
- Possibility for voltage controlled paper drive
- Crest factor up to 10

USES:

- Recording of AC signals from 2 Hz to 200 kHz
- Recording of DC signals
- X-Y Recording
- Statistical level analysis
- Automatic recording of for example:
  - Frequency analyses
  - Frequency response curves
  - Directional characteristics
  - Reverberation decay curves
  - Sound and vibration isolation



The Level Recorder Type 2307 is basically a recording voltmeter designed to accurately record the RMS, Average, or Peak level of an AC signal in the frequency range from 2 Hz to 200 kHz as well as DC signals.

Recordings as a function of time or frequency can be made on preprinted lined or frequency graduated strip-chart paper, 50 or 100 mm wide. Directional recordings can be made on preprinted polar paper, 200 mm in diameter.

When used in conjunction with the B & K frequency analyzing setups and generators, synchronization between the movement of the frequency calibrated paper on the recorder and the frequency scanning of these instruments can be obtained so that frequency analyses and response curves are automatically recorded.

The dynamic range of the Level Recorder is determined by whatever Potentiometer is inserted. There are six of these available, 2 linear, and 4 logarithmic which can be interchanged in a matter of seconds.

A reversible synchronous motor with very short stop and start times is the prime mover in the paper drive system. It makes it possible to electronically control all paper drive functions giving a very easy manual operation and allowing numerous remote control facilities.

An important feature of the drive system is that the paper movement in both directions can be controlled by an external DC voltage. This enables the 2307 to be used as an X-Y recorder allowing the relationship between two varying voltages to be recorded. With the aid of suitable converters, for example frequency to DC, the X-axis can of course be used to represent any quantity.

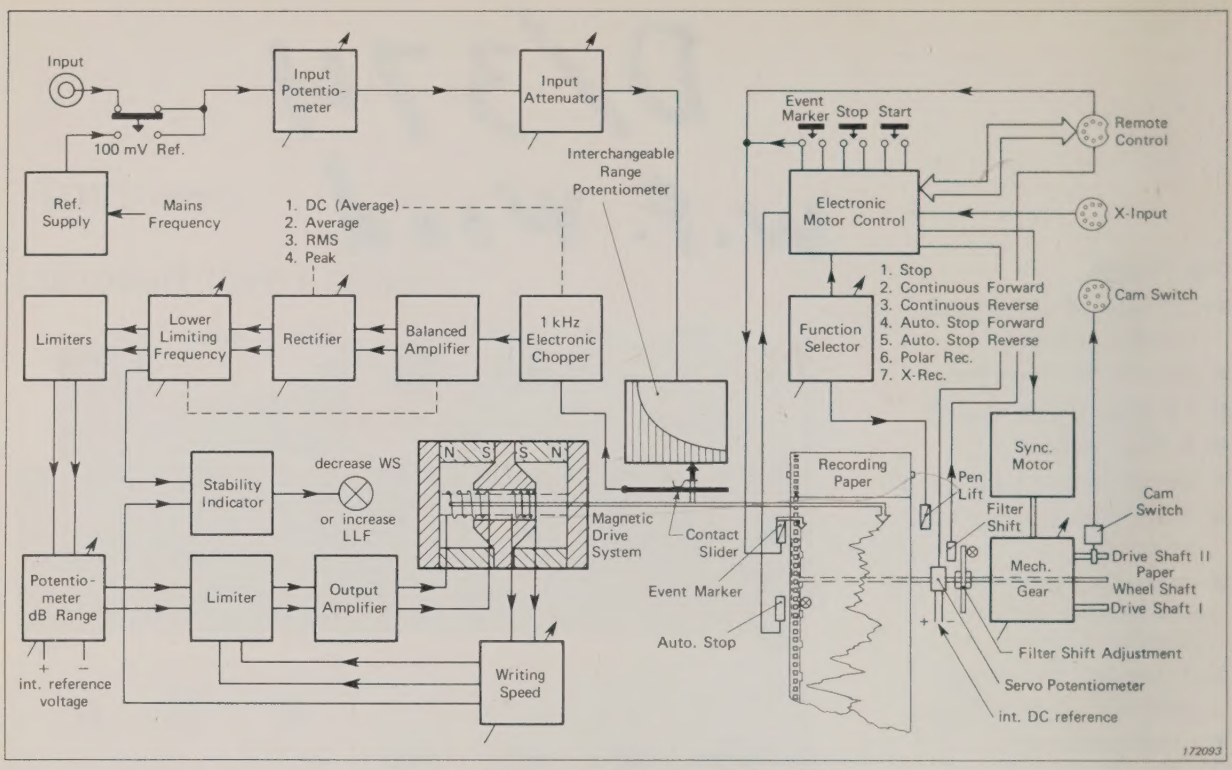


Fig.1. Block diagram of the Level Recorder Type 2307

Electrical Description

Recording System

The Level Recorder operates as an automatic null balancing bridge, see the block diagram in Fig.1. The input signal is applied to the interchangeable Range Potentiometer via a continuously variable input potentiometer and a calibrated input attenuator.

The wiper at the Range Potentiometer is linked with the pen drive. The signal at the wiper is amplified, detected, and then compared with an internal reference voltage. If the detected signal differs from the reference, a difference voltage results. This is amplified and fed to the drive coil of the magnetic drive system.

Current flow in the drive coil forces it to move along with the potentiometer wiper and the writing mechanism. The direction of motion depends upon the polarity of the difference voltage and the wiper moves to that contact which produces a zero difference voltage.

The system maintains a constant signal level at the detector, which can therefore operate within its most linear region, regardless of the dynamic range of the input to the recorder.

A second coil in the drive system generates a velocity dependent signal which is fed back to the drive coil amplifier circuitry. The strength of this feedback signal controls the speed with which the drive system reacts to a change in input signal level. The WRITING SPEED setting provides this control.

Signal Input

Input to the recorder is achieved via a 14 mm coaxial socket for standard B & K plugs. A ground socket is also provided enabling banana plugs to be used. A BNC input socket is available at the rear of the instrument.

Input Circuitry

The input signal can be attenuated continuously over a range of approximately 12 dB by the INPUT POTENTIOMETER. The INPUT ATTENUATOR attenuates the signal in six accurate 10 dB steps. With these two controls the pen/stylus position can be adjusted to obtain the desired base-line calibration. A push button operated 100 mV reference voltage is provided for easy calibration.

Range Potentiometers

The interchangeable Range Potentiometer determines the dynamic range of the recorder. Six different potentiometers are available, two linear, and four logarithmic with dynamic ranges of 10, 25, 50 and 75 dB.

The Range Potentiometer consists of precision resistors connected to a contact strip built-up of 216 silver lamellae. A silver wiper and silver contact strip assure a high signal-to-noise ratio.

Resolution

The resolution of the recorder is the degree by which it is able to record the details in the signal level variations. Firm control over the stylus is essential for a good chart record. The writing system provides a driving force of 9 newtons, but the

resolving power depends upon the voltage between contacts of the Range Potentiometer. The resolving power is adjustable by the POTENTIOMETER RANGE attenuator which controls the difference signal applied to the drive coil. The POTENTIOMETER RANGE setting is normally matched to the Range Potentiometer being used, but it may be switched to give additional resolving power for the recording of fast changes in input signal level.

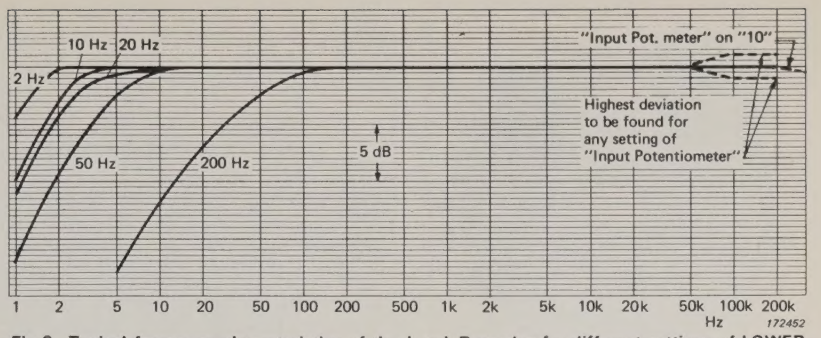


Fig.2. Typical frequency characteristics of the Level Recorder for different settings of LOWER LIMITING FREQUENCY

Averaging Time

Time-averaging is required for the measurement of varying signals. The proper choice of averaging time is essential for correct recordings of details in the signal and for smoothing out fluctuations when recording the mean value of random signals.

The averaging time of the Level Recorder is determined by the setting of the WRITING SPEED control. This switch selects the amount of negative feedback from the velocity coil to the input of the output amplifier section.

The LOWER LIMITING FREQUENCY control determines the lowest frequency to which the recorder responds correctly, see Fig.2.

The lower limiting frequency limit may be adjusted to be 2, 10, 20, 50, or 200 Hz. Writing speeds can be selected from 2 to 2000 mm/s giving effective averaging times from the order of seconds down to approximately 10 ms.

The Level Recorder Type 2307 is equipped with a warning lamp indicating when an unstable combination of LOWER LIMITING FREQUENCY and WRITING SPEED has been selected. This lamp also indicates the action to be taken to achieve stable operation when the POTENTIOMETER RANGE setting is matched to the inserted logarithmic Range Potentiometer.

AC Recording

The Level Recorder will record the absolute arithmetic average, the root mean square (RMS) or the instantaneous half peak-to-peak value of any waveform from 2 Hz to 200 kHz. The recorded RMS value is accurate to within ± 0,5 dB for signals with crest factors up to 10 (crest factor = Peak/RMS ratio). Phase distortion will not affect the RMS accuracy.

DC Recording

In the DC recording mode a 1 kHz electronic chopper is introduced before the average rectifier. Average detection has been chosen to reduce the influence of extraneous noise. In this mode the writing system can follow with full scale deflection a sinusoidal input of up to 6,4 Hz.

Mechanical Description

General

The mechanical section of the Level Recorder consists of a pen drive system, an event marker facility and a paper drive mechanism.

As well as driving the paper, the paper drive mechanism also incorporates an automatic stop device for single chart recording, synchronization of external instruments with paper movement, and control of a multiplexing switch used e.g. for two channel recording.

Two drive shafts are led out for driving external equipment. One of them can also be used as an input for external mechanical control of the paper movement.

Recording System

The Level Recorder is capable of writing on 50 mm and 100 mm widths of strip chart recording paper and on 200 mm dia. polar paper. For 50 mm writing width the moving arm is coupled directly to the pen holder. For 100 mm writing width a very accurate wire driven mechanical gear transforms the movement of the drive coil into the required pen movement. To change from 50 mm writing width to 100 mm, it is only necessary to shift the moving arm snap-lock mechanism from the pen holder to the wire gear.

When recording on polar paper a small pin supplied is inserted through the hole in the centre of the paper and into a hole in the writing platform. A Turntable Type 3922 is available for rotating an object in synchronism with the polar paper, see Accessories section.

A Pen Lift mechanism enables the pen to be lifted from the paper whenever desired. The Pen Lift is automatically activated when the paper drive is in reverse mode, and when the PEN DRIVE is set to "Off" (the stand-by position). Pen lifting can also be manually or remotely controlled.

The Recorder is also furnished with an Event Marker facility whose markings at the chart border can re-

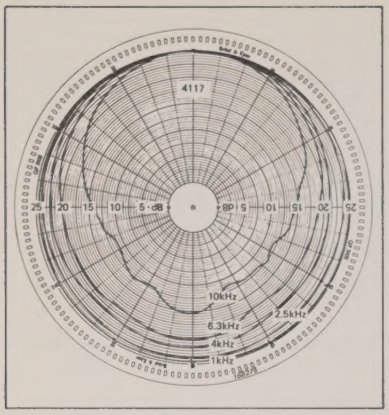


Fig.3. Directional characteristic recorded on the Level Recorder

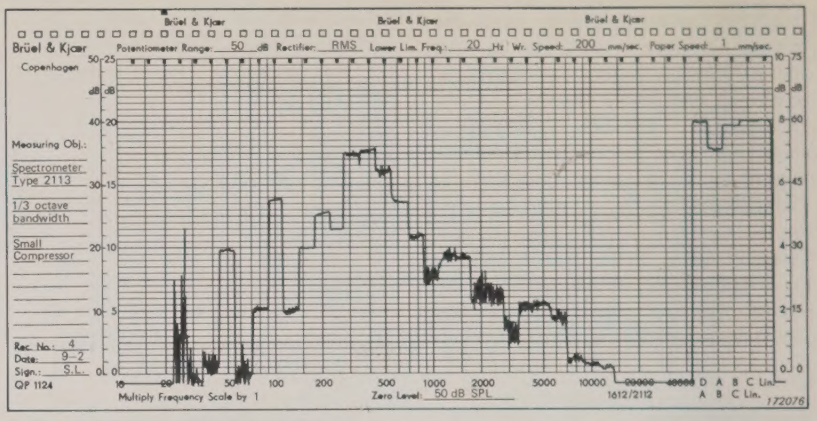


Fig.4. Third-octave frequency analysis recorded on the Level Recorder

present frequency, time, or other quantities as required. The event marking can be controlled manually or remotely.

The writing system uses either pens loaded with ink cartridges or disposable fibre pens for writing on white paper, or sapphire styli for writing on white-wax-coated paper.

Inking Kits Supplied

The recorder is supplied with an inking kit containing 30 ink cartridges and 4 pens.

Extra Inking Kits are available as well as Ink Sets containing 100 cartridges of ink. The Fibre Pens are available in sets of six. See "Accessories" section for description and order numbers.

Paper Drive

The 2307 paper drive uses a special motor with very short start and stop times. This has made it possible to electronically control all paper drive functions giving very easy manual operation and allowing numerous remote control facilities. With 50 Hz power supply the starting and stopping times are as short as 15 ms, and time for reversal of paper direction is 70 ms.

The paper drive has selectable fixed speeds in both directions. The mode of operation can be either continuous or automatic stop for every 250 mm of paper feed, which corresponds to one chart length of preprinted, frequency calibrated paper. The automatic stop functions in both directions allowing more than one recording to be made on a single paper chart without loosing synchronization with coupled instruments. Before a measurement is started, a finger wheel and a friction clutch in the paper drive mechanism allows the paper position to be adjusted as desired.

The slowest paper speed is 0,0003 mm/s giving over 6 years of continuous recording on a 60 m roll of paper. The fastest speed is 100 mm/s enabling accurate plotting of very rapid signal fluctuations. The paper speed accuracy is determined solely by the accuracy of the power line frequency.

X-Control

The paper drive movement in both directions can also be controlled over 250 mm by an external DC voltage. Positive or negative going ramp voltages can be applied. With this ability the 2307 can be used as X-Y recorder to record the relationship between two varying voltages. The maximum chart speed for X-Y recording is 30 mm/s.

An additional feature of the X-Control is that information regarding the position of the chart can be fed directly from the 10 kΩ servo potentiometer into a high impedance circuit which can be used, for instance, for electrical synchronization with the B & K Generators and Analyzer 2010.

Mechanical Outputs

There are three mechanical outputs from the recorder, namely a Paper Wheel Shaft output and two Drive Shaft outputs with independently adjustable rotational speeds.

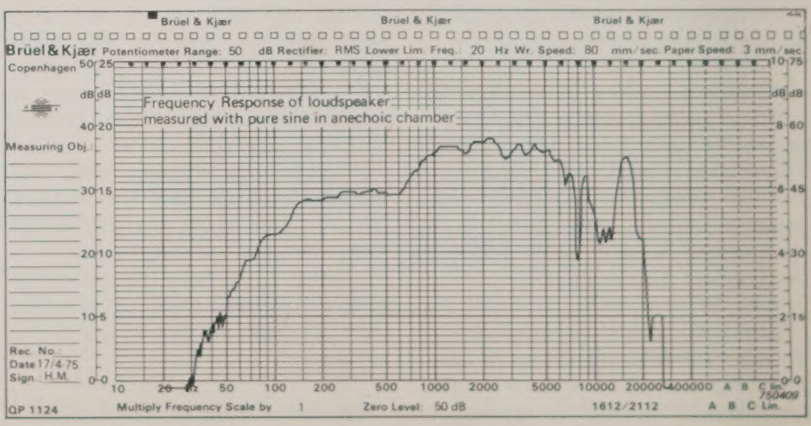

Brüel & Kjær
Brüel & Kjær Potentiometer Range: 50 dB Rectifier: RMS Lower Lim. Freq.: 20 Hz Wr. Speed: 80 mm/sec. Paper Speed: 3 mm/sec.
Copenhagen
Frequency Response of loudspeaker measured with pure sine in anechoic chamber
Measuring Obj.
Rec. No.:
Date 17/4 75
Sign.: H.M.
QP 1124
Multiply Frequency Scale by 1
Zero Level: 50 dB
1612/2112
750409

Fig.5. Frequency response of loudspeaker recorded on the Level Recorder

The two Drive Shafts are used to drive the frequency scan of the B & K Generators and Frequency Analyzers in synchronism with the motion of the frequency calibrated paper in the recorder. The shafts can also be used to drive any other external equipment.

Paper Wheel Shaft: Provision is made for a 6 mm spindle to be coupled directly onto this shaft. It rotates once for every 250 mm of paper throw, (one chart length).

Drive Shaft I: This shaft is mainly intended to be used in connection with recording on preprinted, frequency calibrated paper. As the speed of both Drive Shaft I and the paper is controlled by the PAPER SPEED knob, the speed may be changed during the recording of frequency response curves or spectrograms without upsetting the synchronism between the calibrated recording paper and the coupled Generator or Analyzer.

Drive Shaft II: The speed of this shaft is independent of the paper speed, but it has the same speed possibilities as Drive Shaft I. Drive Shaft II can be used, for instance, to record frequency response curves in a compressed or enlarged frequency scale when the Generator is driven from this shaft.

Remote Control

Various functions of the Level Recorder can be remotely controlled, and the Recorder itself can be used to control externally connected instruments, such as Generators and Frequency Analyzers. The X-Control and the Mechanical Outputs have already been described. Additionally the Recorder is equipped with two sockets used for various control functions.

Remote Control Socket

The synchronizing pulses for connected B & K Filter Sets are supplied from this socket. Additionally it gives all connections required for remote control of the recorder (except the X-control). Remote control facilities, for instance for recording of spectra displayed on the Real Time Analyzers Type 2031, 2033 and 2131, include start, stop, automatic stop, pen lift, and event marking.

Cam Switch Socket

This socket is connected to a cam-operated microswitch equipped with a make-break transfer contact. The cam is driven by the Drive Shaft II. It can be used as a multiplexing switch for two channel recording, or for pen lifting, marking, timing, etc.

Recording Paper

General

Two different paper types with various preprints are available: White paper for ink writing and white-wax-coated black paper for stylus writing. The wax coated paper is available in 50 mm width rolls, whereas the paper for ink is available in both 50 mm and 100 mm width rolls and as polar diagram paper.

Paper for Ink Writing

This paper is well suited for copying either photographically or by a process where the light passes through the original. The ink paper is not recommended for use with the very fastest or very slowest paper speeds. For this purpose the wax coated paper is better suited.

White-Wax-Coated Black Paper

This has a black paper base coated on the front with a thin white wax layer. The recording is made with a stylus which removes the wax coating leaving a thin black line. The wax coated paper is well suited for all Recorder paper and writing speeds. It is preferred for the recording of reverberation curves, for example, where fast writing speeds are used. Copying requires a photographic process.

Accessories

Inking Kit QI 0002

This kit is similar to the Inking Kit supplied with the 2307. It contains:

10	cartridges of black ink	QI 0101
10	cartridges of red ink	QI 0201
10	cartridges of green ink	QI 0301
4	inking pens	DH 2001

Fig.6. Inking Kit QI 0002

Fibre Pens

Fibre Pens are available in sets as follows:

QI 0003	2 each, black, red and green
QI 0004	6 black
QI 0005	6 red
QI 0006	6 green

Ink Sets

Extra ink cartridges are available in sets as follows:

QI 0100	100 black
QI 0200	100 red
QI 0300	100 green

Range Potentiometers

Two linear and four logarithmic Range Potentiometers are available fitting both Type 2307 and the earlier Type 2305. For a full description and the order numbers, see under "Dynamic Range" in the "Specification" section.

Fig.7. Interchangeable Range Potentiometer

Sets type of rectification desired True root mean square value arithmetic average value or half peak-to-peak value, plus DC

Sets lower limiting frequency of the recorder's frequency range

Adjustment of the writing speed of the pen. Setting should be matched with lower limiting frequency setting

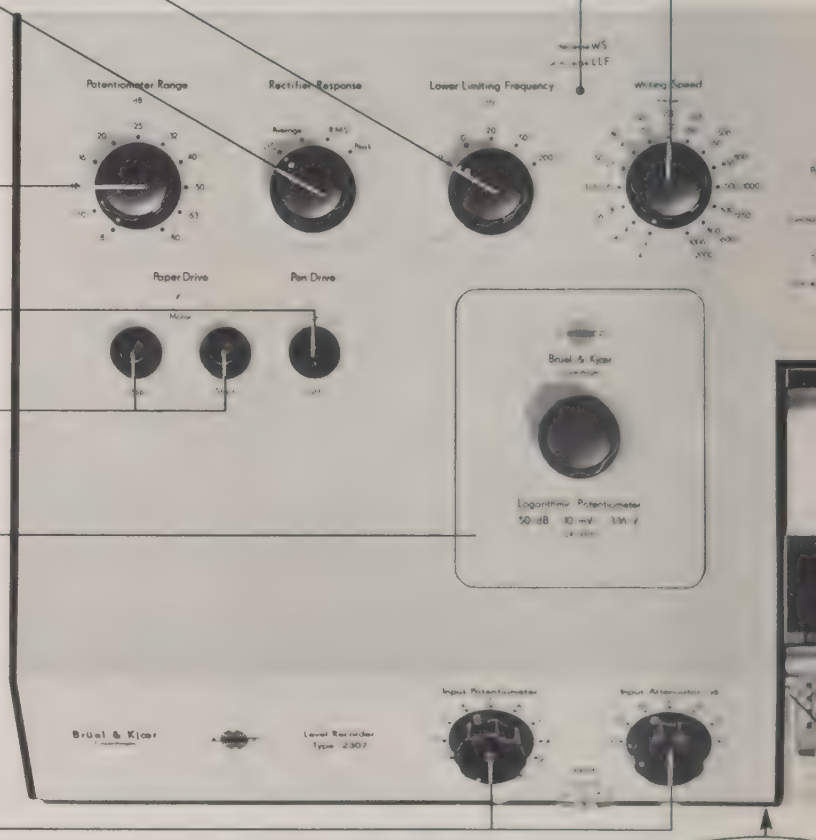
Warning light for incorrect combination of lower limiting frequency and writing speed

Sets resolving power of the writing system. Should normally be set to same dB value as potentiometer chosen

Switches the pen drive off or on. In "Off" mode pen is lifted clear of paper

Start and stop of paper drive

Interchangeable range potentiometer. Determines dynamic range of recording. Can be 10, 25, 50 or 75 dB or linear from 5 to 17,5 or 55 mV



Set input sensitivity

Push button for applying reference signal to input. Allows easy calibration

Input socket
Supplemented with BNC socket at rear of recorder

ush button for recording markers
paper edge. Can be remotely con-
olled

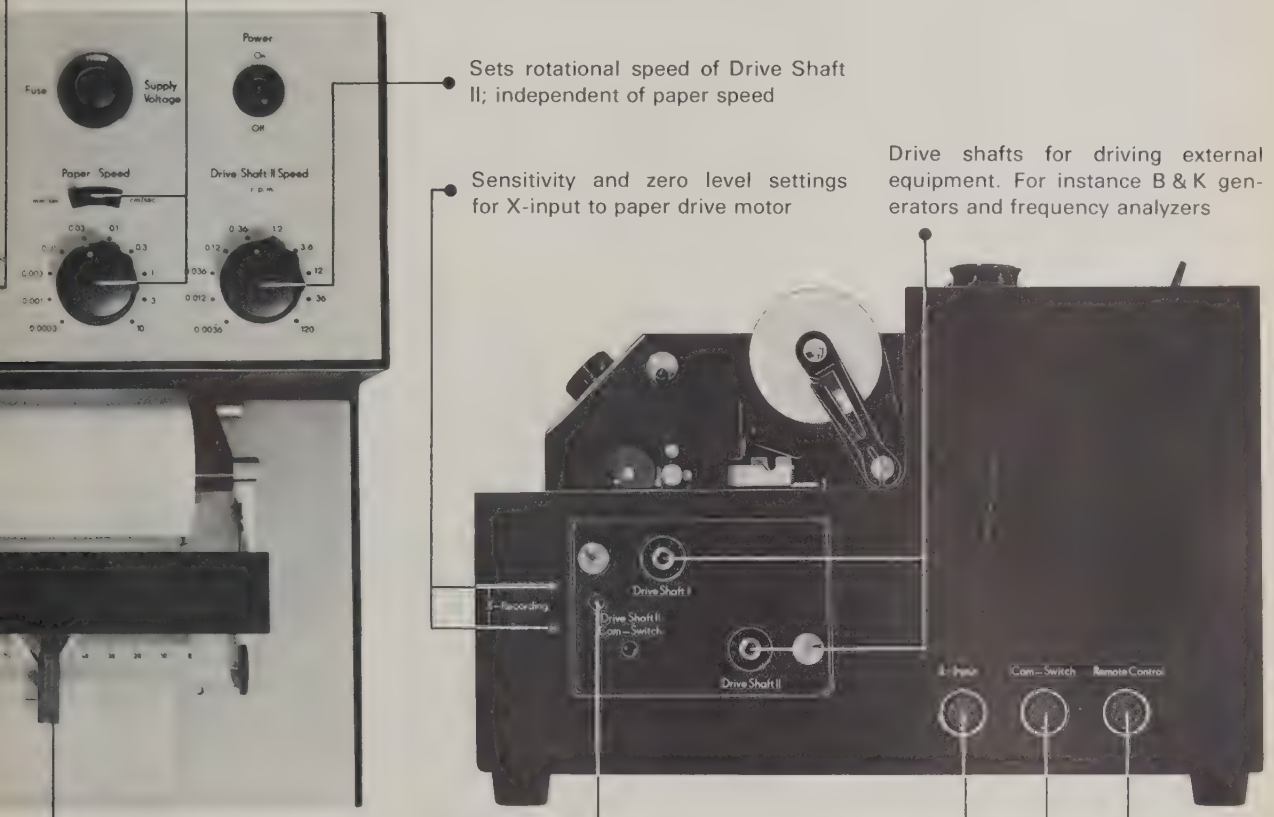
elects paper drive mode for auto-
atic and semi-automatic recording

Sets paper speed. Rotation speed of Drive Shaft I follows this setting

Sets rotational speed of Drive Shaft II; independent of paper speed

Sensitivity and zero level settings for X-input to paper drive motor

Drive shafts for driving external equipment. For instance B & K generators and frequency analyzers



Ink pen, may be replaced by fibre pen or sapphire stylus

Holder for Event Marker pen

Input socket for signal to X-input drive of recording paper. May also give output information on paper position

Connection socket for built-in cam switch to control of other equipment, etc.

Paper drive shaft outlet for external mechanical control of paper movement

Input socket for remote control of paper movement, event marker etc Also supplies filter shift pulses to B & K filters. Socket duplicated at rear

Thumb wheels for manually moving paper, setting of automatic stop and filter shift pulse timing relative to paper position

Chain Drive UA 0440

This chain drive is used to drive associated instruments when Type 2307 is mounted in a rack. The kit is included with the 2307 C, and may be ordered separately for the 2307 A and 2307 B.

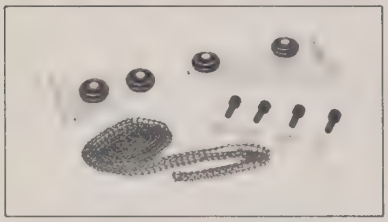


Fig.8. Chain Drive UA 0440

Flexible Shaft UB 0041

The UB 0041 Flexible Shaft may be used to mechanically drive instruments that are not rack mounted. This shaft is used to drive the B & K Generators Types 1023 and 1027 and the Frequency Analyzers 2120, 2121 and 2010 with which instruments it is included.

Mechanical Extension Connector UB 0009

This connector is used for interconnection of two Flexible Shafts UB 0041.

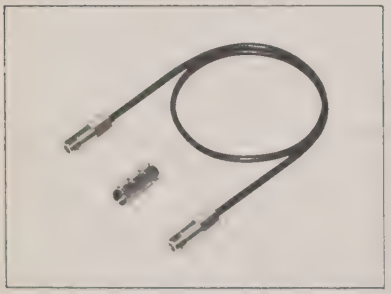


Fig.9. Flexible Shaft UB 0041 and Mechanical Adaptor UB 0009

Gear UG 3000

This 10:1 gear should be used if the Level Recorder is employed in a set-up with the Heterodyne Slave Filter Type 2020 and Generator 1023. The gear should be driven by a Flexible Shaft UB 0041 and screws directly into the B & K Generator Type 1023. It secures a more accurate sweep speed regulation.

Fig.10. Gear UG 3000

Turntable 3922

The Turntable Type 3922 is designed to synchronize the rotation of a test object with a polar chart paper on the Level Recorder to provide automatic polar diagrams.

The 3922 contains a synchronous motor drive with very short start and stop times. The Level Recorder's paper drive and the Turntable can be operated simultaneously at either location. The movement can be continuous rotation, rotation with automatic stop, or sweep within adjustable angles. Typical applications are recording the directional characteristics of microphones, loudspeakers, hydrophones, and radio and TV antennae.

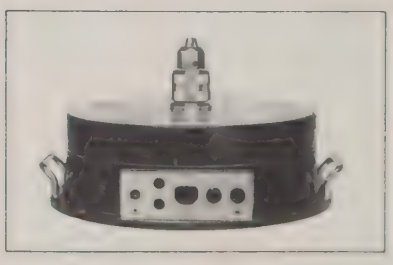


Fig.11. Turntable Type 3922

Response Test Unit Type 4416

The Response Test Unit 4416 allows synchronization between prerecorded tapes or test records, as used for frequency response measurements on sound reproducing systems, and the frequency calibrated recording paper. The 4416 starts the paper drive of the Level Recorder when a 1 kHz prerecorded tone ceases. For recording of test-tapes the 4416 is used to start the frequency scan of the B & K Generators after cessation of a 1 kHz tone. It also includes the standardized A and B rumble filters and facilities for equalization when testing tape recorders and gramophone pick-ups with the stereophonic test records QR 2009, QR 2010 and QR 2011. A two channel selector is included for cross-talk measurements in stereophonic systems.

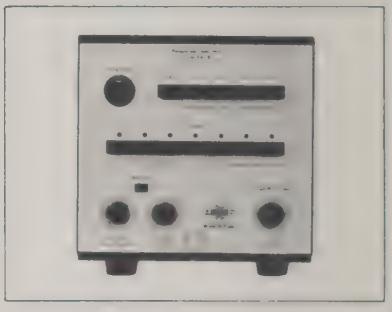


Fig.12. Response Test Unit Type 4416

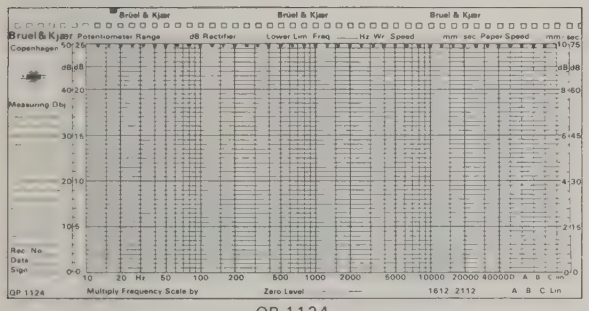
Protractor SC 2361

The Protractor SC 2361 is used in reverberation time measurements for easy determination of the decay time from the slope of the recorded curve.

Fig.13. Protractor SC 2361

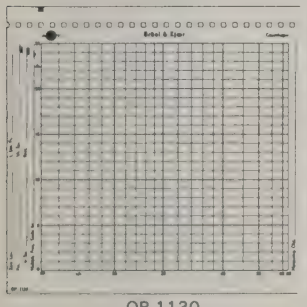
Recording paper for Type 2307 (and earlier model 2305). Rolls of 60 m

Type of Preprint	Level graduated	Level and Frequency graduated	Level and Logarithmically Frequency graduated						Level and Frequency graduated
			10 Hz—40 kHz	1.6 Hz—160 kHz	2 Hz—200 kHz	1 Hz—20 kHz	10 Hz—40 kHz	100 Hz—10 kHz	
For Use with Instrument Types	For example 2010(Lin. scale) 1027(Lin. scale) 1023(Lin. scale)	2031 2033	1023/27 1613/16/(18) (2010),2215	1617 1618 2131	1027 2010 1621, 23	1621 1623	1613 1616	3356	2120
White Paper for Ink Writing width 100 mm	QP 1102	QP 1103	QP 1124	QP 1153	QP 1143		—	QP 1142	QP 1130
White Paper for Ink Writing width 50 mm	QP 0102	—	QP 0124	—	QP 0143	QP 0120	QP 0150	—	—
White-waxed Black Paper for Stylus Writing width 50 mm	QP 0202	—	QP 0224	—	—		—		—
QP 5102 Polar Diagram Charts for Ink Writing. Radius 100 mm. Used with 2305 or 2307 and Turntable Type 3922. Packages of 100 sheets.									

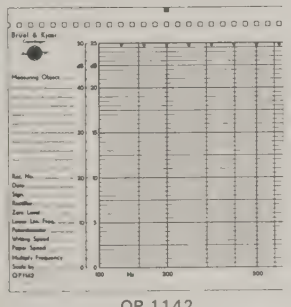


QP 1124

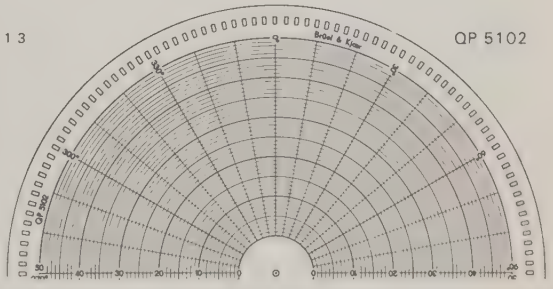
QP 1103

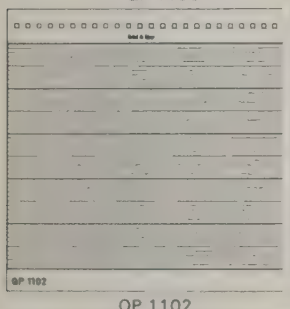


QP 1130



QP 1142





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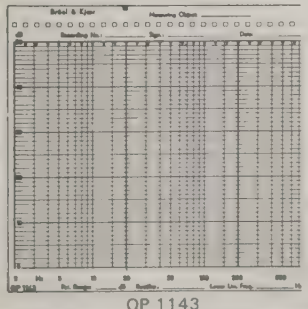
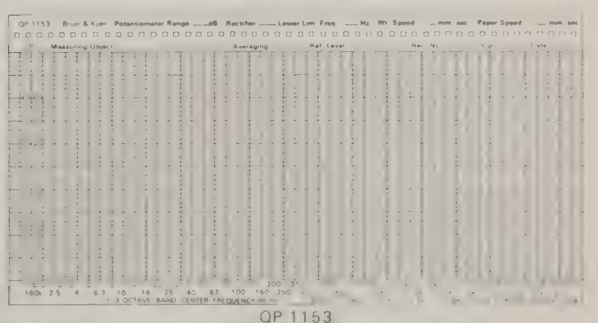
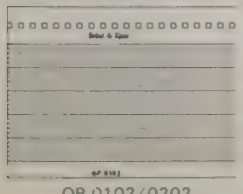


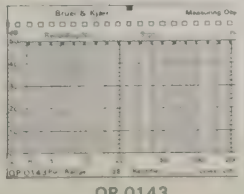
QP 1143



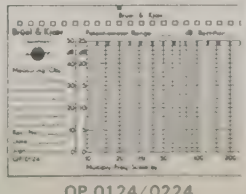
QP 1153



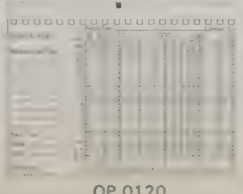
QP 0102/0202



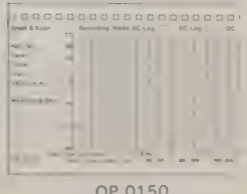
QP 0143



QP 0124/0224



QP 0120



QP 0150

Combining System

To enable the Level Recorder, which forms the center part in very many measuring systems, to be mounted together with the other instruments in the system a set of metal cabinets is available.

This combining system offers a wide selection of possibilities for combining standard instruments with the Level Recorder Type 2307 as the basic instrument.

When mounted in the combining system, the generators, frequency analyzers and filters can be automatically frequency scanned, electrically or mechanically, controlled from the Level Recorder. This provides neat, compact set-ups for automatic recording of frequency analyses, frequency response curves, reverberation decay curves etc. on frequency calibrated paper.

The system consists of 4 Combining Units of different heights, and blank panels, separation shelves, mounting sets and chain drive assemblies which, depending on the choice of instruments, should be ordered separately. The Combining Units accept both 380 mm wide instruments and 430 mm wide instruments as well as instruments in B & K Modular Cassettes mounted in a KK 0014 metal cabinet.

For full information on this system please ask for special literature.

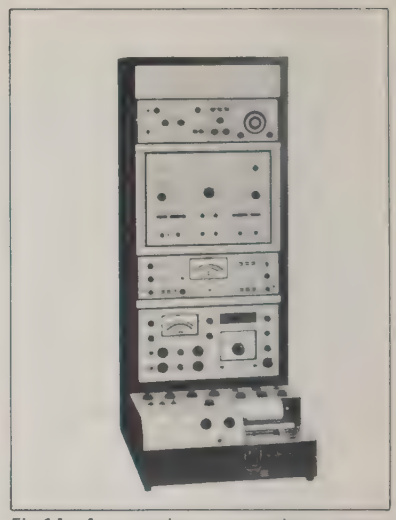


Fig.14. A complete measuring system mounted in a combining unit

Use of the Level Recorder with other Brüel & Kjær Instruments

Frequency and Phase Response Recording

The Level Recorder Type 2307 offers an excellent means of plotting frequency response curves automatically. The sketch to the right indicates the basic set-up possibilities with B & K instruments. Both generators include a compressor circuit for automatic output level regulation. The Heterodyne Slave Filter Type 2020 is tuned from one of the generators and may be included either to suppress background noise or for frequency analysis. The B & K Heterodyne Analyzer Type 2010 may be used in similar set-ups, as shown below. A Tracking Frequency Multiplier Type 1901 may be included for harmonic analysis and a Phase Meter 2971 for phase response measurements.

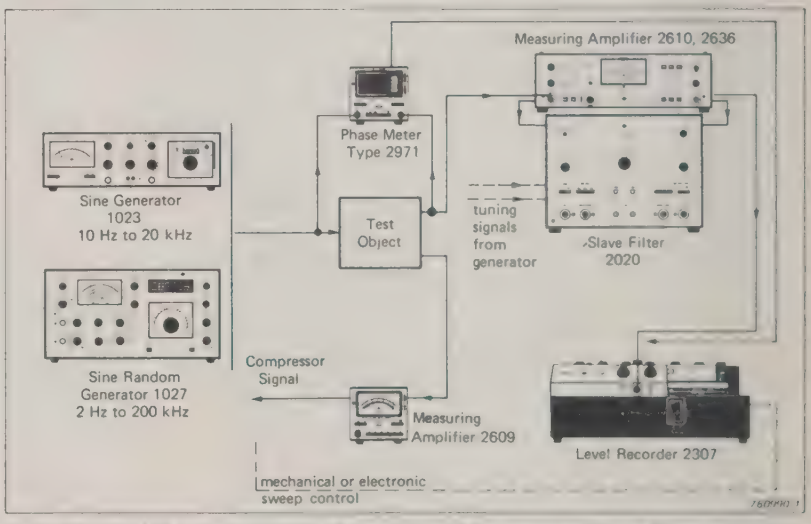

Measuring Amplifier 2610, 2636
Phase Meter Type 2971
Sine Generator 1023 10 Hz to 20 kHz
Test Object
tuning signals from generator
Slave Filter 2020
Sine Random Generator 1027 2 Hz to 200 kHz
Compressor Signal
Measuring Amplifier 2609
Level Recorder 2307
mechanical or electronic sweep control

Fig.15. Typical set-up possibilities for recording of Frequency and Phase Characteristics

Distortion Measurements

The Heterodyne Analyzer Type 2010 can be used in a wide variety of set-ups with the Level Recorder. To the right is shown a set-up using the Distortion Measurement Control Unit Type 1902 which, together with this Analyzer, allows direct plotting of swept measurements of harmonic, difference frequency and intermodulation distortion curves.

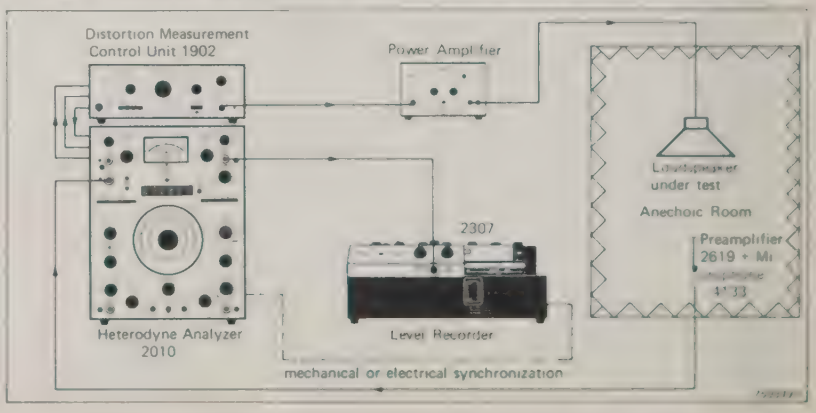


Fig.16. Set-up for recording the distortion characteristics of a loudspeaker

Polar Diagram Recording

To the right is shown a typical set-up for recording directional characteristics at different frequencies. Here it is a loudspeaker under test but microphones, hydrophones, projectors and antennae, for example, can also be tested in this way. The Turntable can either rotate a full 360° or be set to swing forth and back within a desired angle.

Frequency Analysis Recording

The Level Recorder Type 2307 can be used with all of the B & K frequency analyzers and filters for automatic recording of frequency analyses. The sketch to the right shows it used for analysis of vibration level with the Analyzer Type 2120 which has bandwidths from 1% to 23%.

The Recorder also provides an excellent means for providing a permanent record of octave and 1/3 octave analyses generated by the Digital Frequency Analyzer Type 2131. Alternatively narrow band analysis generated by the Digital Frequency Analyzers Types 2031 and 2033 may be recorded. Recording is made on frequency graduated paper under control of the 2307 or of the particular Analyzer employed. Using the 75 dB potentiometer the entire 60 dB range of the 2131 and 70 dB range of the 2031 and 2033 may be recorded. For increased resolution, the 50 dB potentiometer may be used.

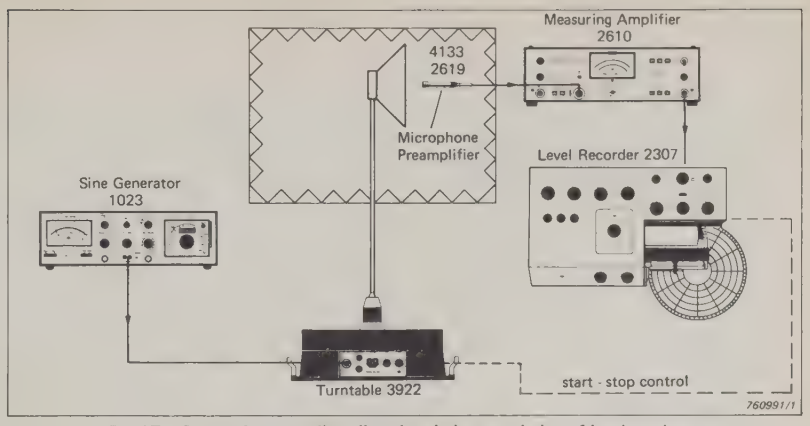


Fig.17. Set-up for recording directional characteristics of loudspeakers

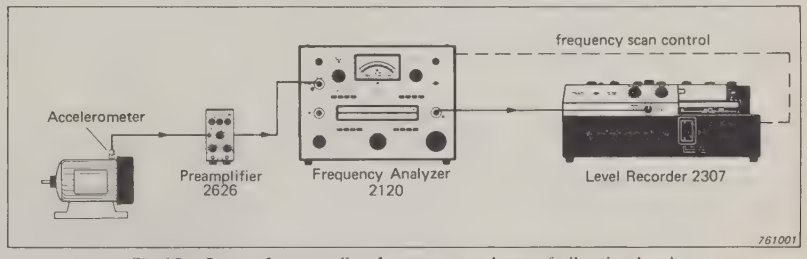


Fig.18. Set-up for recording frequency analyses of vibration level

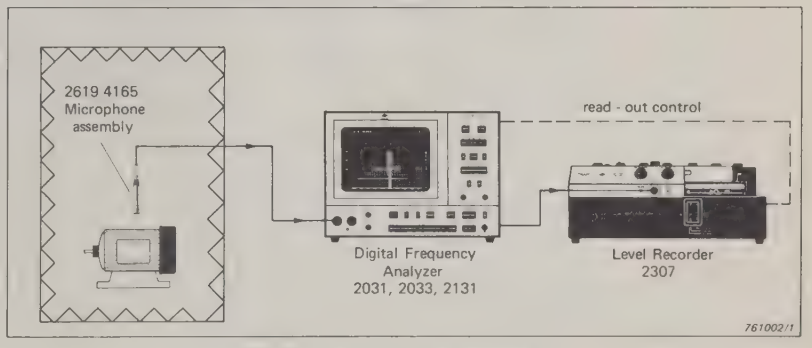


Fig.19. Set-up for noise analysis

Specifications 2307

ELECTRONIC

Frequency Range

AC: 2 Hz to 200 kHz ± 0,5 dB (re 1 kHz) with INPUT POTENTIOMETER at position 10; ± 1 dB for other positions.
DC: 1 kHz electronic chopper
Full scale response time: (DC) Down to 50 ms

Sensitivity:

Minimum voltage to hold pen/stylus at 0 dB position on chart with INPUT POTENTIOMETER at 10 and INPUT ATTENUATOR at 0 dB
With Range Potentiometers ZR 0001, ZR 0002, ZR 0004, ZR 0005 and ZR 0006: AC: 5 mV RMS DC: 5 mV
With Range Potentiometer ZR 0003: AC 50 mV RMS. DC: 50 mV

Dynamic Range: (Determined by Range Potentiometer)

Range Potentiometer	Response	Dynamic Range	Voltage Range* AC (RMS) and DC	Accuracy***
ZR 0001	LIN		5 to 17,5 mV	2% of full scale
ZR 0002	LIN	–	5 to 55 mV	2% of full scale
ZR 0003	LOG	10 dB	50 to 160 mV	± 0,1 dB
ZR 0004	LOG	25 dB	5 to 90 mV	± 0,2 dB
ZR 0005**	LOG	50 dB	5 mV to 1,6 V	± 0,3 dB
ZR 0006	LOG	75 dB	5 mV to 28 V	± 0,5 dB

* INPUT POTENTIOMETER at 10, INPUT ATTENUATOR at 0 dB (highest sensitivity)
** Supplied unless otherwise specified
*** The accuracy refers to the Range Potentiometer alone and represents the smallest possible change in level that can be detected by the lamellae stack

Resolution
Better than ± 0,25 mm for 50 mm chart width and ± 0,5 mm for 100 mm chart width. With a 50 dB Range Potentiometer this represents ± 0,25 dB

Input Circuit:
Input Impedance: 24 kΩ|| 60 pF to 12 kΩ|| 120 pF depending on position of INPUT POTENTIOMETER (0 to 10)
Max. Input Voltage: 100 V RMS
Input Potentiometer: 0 to 12 dB, non-calibrated
Input Attenuator: Six 10 dB steps re position 0 ± 0,25 dB

Rectifier Response:
RMS: ± 0,5 dB, for crest factors up to 10
Average: ± 0,5 dB, true arithmetic average
Peak: ± 1 dB, half peak-to-peak
DC: ± 1 dB, 1 kHz chopped
Average detection

Calibration Reference:
100 mV RMS square wave at mains frequency
Stability: ± 1% for ± 10% deviation in mains voltage

Writing Speeds:
50 mm chart width: 2; 4; 8; 16; 25; 40; 63; 100; 160; 250; 400; 500; 630; 800; and 1000 mm/s
100 mm chart width: 4; 8; 16; 31,5; 50; 80; 125; 200; 315; 500; 800; 1000; 1250; 1600; and 2000 mm/s

Lower Limiting Frequency:
2, 10, 20, 50, and 200 Hz

Warning Lamp:
Warning light for unstable combinations of WRITING SPEED and LOWER LIMITING FREQUENCY

Writing System:
Electrodynamic. Driving force 9 N
50 or 100 mm writing width

Overall Stability:
± 0,2 dB variation in stylus deflection for ± 10% drift in mains supply voltage

MECHANICAL

Paper Drive:
General: Reversible self-starting synchronous motor with gear box. Starting and stopping time 15 ms, 70 ms reversal time, for 50 Hz mains supply
Paper position can be controlled via X-REC facility
Features: Selectable fixed speeds in both directions
Automatic stop every 250 mm (one chart length) in both directions
Continuous drive in both directions
Automatic stop for one revolution or sweep with adjustable limits with polar paper and Turntable Type 3922

Paper Speeds:
0,0003; 0,001; 0,003; 0,01; 0,03; 0,1; 0,3; 1; 3, and 10; selectable in mm/s and cm/s

X-Control:
Ramp Limits: ± 20 V DC
Chart Length: Max. 250 mm
Chart Speed: Max. 30 mm/s
Sensitivity: 15 to 50 mm/V
Zero Position: 0 V on voltage control ramp, adjustable over whole chart length

Types of Recording:
Cartesian and Polar

Writing Pens/Styli:
Ink pens that can be loaded with green, red, or black ink cartridges
Fibre pens in green, red, and black
Sapphire Styli for use with waxed chart paper

Recording Paper:
(see also Table "Recording Paper")
50 mm and 100 mm wide preprinted charts for pens (rolls of 60 m)
50 mm wide waxed preprinted charts for styli (rolls of 60 m)
200 mm diameter polar charts for pens (packets of 100 sheets)

Event Marker:
Positioned at chart border, manual and remote operation
Pen or Stylus mounting
20 pps maximum operating rate

External Drive Facilities:
Two independent drive shafts which may be connected to scanning mechanism of other instruments
Selectable Speeds: 0,0036; 0,012; 0,036; 0,12; 0,36; 1,2; 3,6; 12; 36, and 120 RPM
Max. Allowable Torque: 0,2 Nm (1,7 lbf.in)

Paper Wheel Shaft:
Coupling for 6 mm spindle
Shaft rotates: Once for every 250 mm of paper feed

Control Pulses:
Internal cam switch for output pulses synchronized to chart motion, used, for example, to make filter shifts in externally connected B & K Third-Octave Filter-Sets

Remote Control:
Start, stop, automatic stop, external automatic stop, pen lift, and event marking

Cam Switch:
Multiplexing switch for two channel recording, pen lifting, marking, timing, etc

GENERAL

Temperature Range:
0 to 40°C (32 to 104°F)

Power Supply:
100, 115, 127, 220, 240 V AC ± 10%, 50 or 60 Hz (specify mains frequency when ordering). Complies with safety class I of IEC R 348

Power Consumption:
Approximately 40 VA

Cabinet:
Supplied as model A (steel cabinet), model B (model A in mahogany cabinet with lid), or C (as A, but with chain drive for mounting in 19" racks)

Dimensions: Model A
(excluding knobs, feet, etc.)
Height: 180 mm (7,1 in)
Width: 482 mm (19,0 in)
Depth: 290 mm (11,4 in)

Weight:
20,5 kg (45 lb)

Accessories Included:
1 50 dB Range Potentiometer ZR 0005 (unless otherwise specified)
1 Inking Kit QI 0002
2 Sapphire Styli DH 2003
1 Screened B & K Plug JP 0101
2 7-pin DIN Plugs JP 0703
2 8-pin DIN Plugs JP 0802
1 Roll Recording Paper QP 0202
1 Roll Recording Paper QP 1102
1 Roll Recording Paper QP 1124
1 Decay Time Protractor SC 2361
1 Polar Recording Pin DB 1457
2 Cam Discs OD 0060
2 Cam Discs OD 0061
Power cable, Spare Fuses and Lamps
Additional for model C: 1 Chain Drive Assembly UA 0440

Accessories Available:
See section "Accessories"

2. CONTROLS

2.1. TOP PANEL

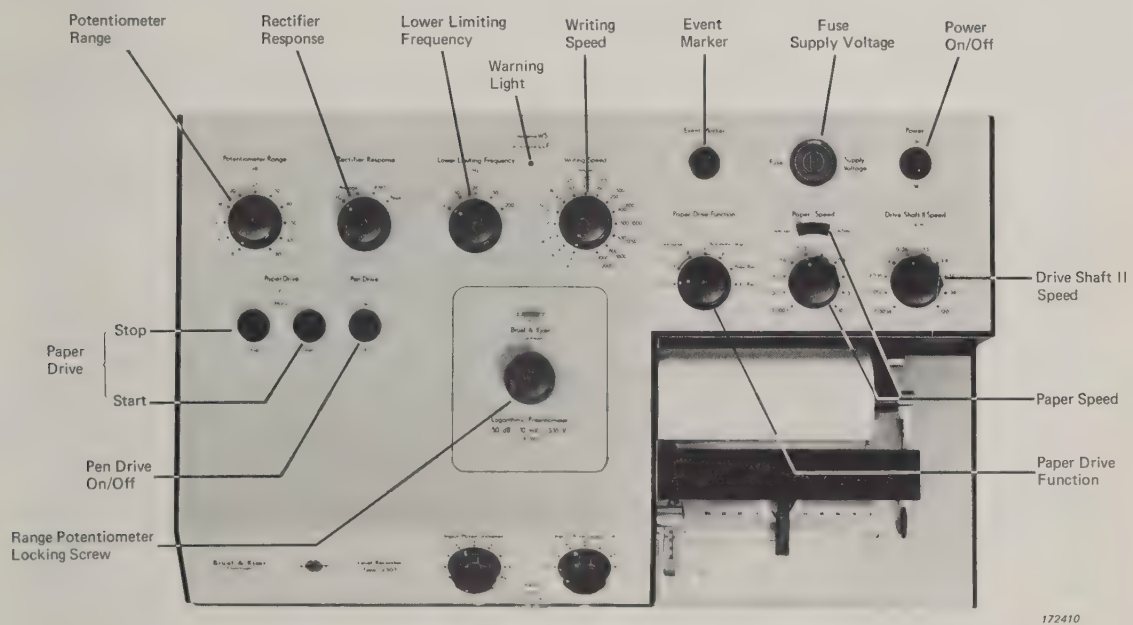


Fig.2.1. Top panel of 2307

SUPPLY VOLTAGE AND FUSE: Mains voltage selector for operation of the Recorder from 100; 115; 127; 220; and 240 V ±10% (50 to 60 Hz) AC supplies. The selector also contains a slow blow mains fuse. To change the selected voltage or fuse see section 3.2.

POWER: "On"-"Off" switch for mains supply. When power is connected the lamp above the recording paper should light.

RECTIFIER RESPONSE: Four position switch for selection of recorded signal level:

"Average" Arithmetic average level
"RMS" True root mean square level
"Peak" Half peak to peak level
"DC" Average level of signal chopped at 1 kHz

LOWER LIMITING FREQUENCY: Five position switch for selection of lower limit of linear frequency range of the Recorder. The limits are 2; 10; 20; 50; and 200 Hz.

The LOWER LIMITING FREQUENCY and WRITING SPEED settings play an important part in determining the stability of the writing system. If an unstable combination of LOWER LIMITING FREQUENCY and WRITING SPEED is selected a LED (Light Emitting Diode) labelled DECREASE WS or INCREASE LLF will light. See section 3.6.

WRITING SPEED:

Fifteen position switch for selection of writing speed of pen. The inner range of figures 2 to 1 000 (mm/s) correspond with recording paper of 50 mm width, and the outer range of figures 4 to 2 000 (mm/s) correspond with recording paper of 100 mm width.

For stable operation of the writing system, the LOWER LIMITING FREQUENCY setting must be considered when selecting WRITING SPEED. See section 3.6.

POTENTIOMETER RANGE:

Eleven-position switch for selecting resolving power of writing system in conjunction with the Range Potentiometer fitted. Commonly used combinations of POTENTIOMETER RANGE setting and Range Potentiometer are shown in Table 3.1.

PAPER SPEED:

A ten-position, spring loaded knob plus two position slider for selection of twelve fixed paper speeds from 0,0003 mm/s to 10 cm/s. To change the setting of the selector knob lift it up against its spring, rotate to the required setting, and release.

The selector knob also controls the speed of DRIVE SHAFT I independently of the slider setting. The speed of DRIVE SHAFT I can be determined by relating the angular setting of the selector knob to a corresponding setting of the DRIVE SHAFT II SPEED knob which is marked in RPM.

DRIVE SHAFT II SPEED:

A ten-position, spring loaded selector knob for selection of ten fixed DRIVE SHAFT II speeds from 0,0036 to 120 RPM, independent of paper speed. Permits compression and expansion of frequency scale when frequency scanning of B & K Frequency Analyzers and Signal Generators is controlled via DRIVE SHAFT II.

PAPER DRIVE FUNCTION:

Seven-position switch used in conjunction with the PAPER DRIVE "Stop"-"Start" push buttons for selection of the following paper drive control functions:

"Stop". Paper drive runs only as long as the "Start" push button is kept depressed.

"Continuous F". When the "Start" push button is pressed the paper drive runs continuously in the forward direction. To stop the paper drive press the "Stop" push button.

"Continuous R". When the "Start" push button is pressed the paper drive runs continuously in the reverse direction. To stop the paper drive, press the "Stop" push button.

"Automatic Stop F". When the "Start" push button is pressed the paper drive runs until the automatic stop is reached or the "Stop" push button is pressed. The automatic stopping point is determined by the AUTOMATIC STOP thumb wheel on the front panel. When correctly adjusted as in section 4.1 the amount of paper travel between

one automatic stopping point and another is 250 mm which with the most commonly used types of recording paper, corresponds to one chart length.

"Automatic Stop R". This function is similar to "Automatic Stop F" except that the paper drive runs in the reverse direction and that the writing and event marker pens are lifted clear of the paper.

"Polar Rec". This function is used for polar recording when the Turntable Type 3922 is used with the Recorder. See section 4.3.

"X Rec". With this function the forward and reverse movement of the paper may be controlled by applying an external ramp voltage to the X INPUT socket on the side panel of the Recorder. The Recorder then behaves in a manner similar to an X—Y recorder. See section 4.2.

EVENT MARKER: A push button which when pressed actuates the event marker pen or stylus, making a step in the event marker line drawn just below the top edge of the paper.

PAPER DRIVE: Two push buttons for starting and stopping the paper drive. Unless external control is present the Recorder will automatically revert to its stop condition when power is momentarily disconnected. A Motor LED above the two buttons lights only when the drive motor is running.

PEN DRIVE: "On-Off" switch for pen drive. In the "Off" position the pen drive is disconnected and the pen lifted clear of the recording paper enabling the pen to be moved by hand to any required position. In the "On" position the pen drive is connected ready for recording.

2.2. FRONT PANEL

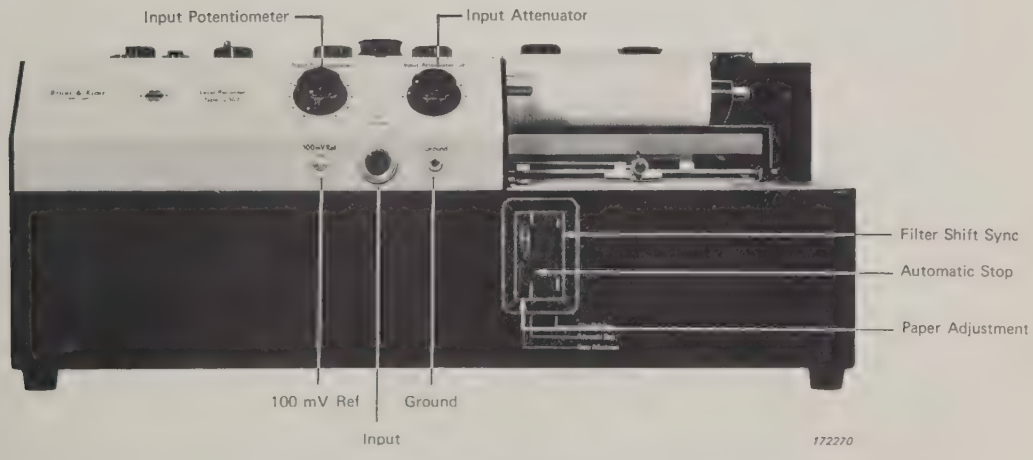


Fig.2.2. Front panel of 2307

INPUT: DC coupled input accepting standard B & K Coaxial Plugs JP 0101 or a BNC Adaptor JP 0144 for application of the signal to be recorded. It has a minimum input impedance of 12 kΩ|| 90 pF and accepts input voltages up to 100 V RMS for full scale pen deflection. However, for operation in accordance with IEC 348, the input current of signals exceed-

ing 42 V peak should be restricted to 0,7 mA. An alternative DC coupled BNC INPUT socket is provided on the rear panel of the Recorder.

GROUND: 4 mm socket accepting a banana plug (B & K No. JB 0002) for connecting the screens of coaxials input cables to the chassis of the Recorder which has a permanent signal ground-chassis connection.

⚠ **WARNING:** The 2307 is designed to be operated with its signal ground lines and chassis always at earth potential. Never let the signal ground terminal, socket screens or chassis float at any other potential, as this will impair the operating safety of the 2307 and may damage the instrument.

INPUT ATTENUATOR: Seven-position switch for attenuation of input signal in 10 dB steps from 0 to 60 dB.

INPUT POTENTIOMETER: Potentiometer for continuous adjustment of input signal level between INPUT ATTENUATOR switch ranges. For a linear response at frequencies up to 200 kHz (see Fig.3.11) the potentiometer should be kept in its extreme clockwise position giving 0 dB attenuation. In the extreme counter clockwise position, the maximum attenuation is approximately 12 dB.

100 mV REF: A self-resetting push button which, when pressed, disconnects the input signal, connecting an internal 100 mV (mains frequency) reference voltage source to the INPUT of the Recorder. For accurate calibration using the reference source, the RECTIFIER RESPONSE switch on the top panel should be set to its "RMS" or "Average" mode. Also avoid using a LOWER LIMITING FREQUENCY switch setting greater than "50" Hz.

PAPER ADJUSTMENT: Access is given to paper drive sprocket wheel, for manual adjustment of paper position.

AUTOMATIC STOP: Thumb wheel for manual adjustment of point where the paper comes to an automatic stop. The amount of adjustment (max. ± 12,5 mm) can be gauged by the relative position of the white spot on the PAPER ADJUSTMENT thumb wheel with respect to the white spot on the AUTOMATIC STOP thumbwheel. The latter will always take up the same position when the paper drive is stopped automatically. See section 4.1.

FILTER SHIFT SYNC: Thumb wheel for manual adjustment of the third octave filter shift pulses of the Recorder so that they are synchronized with the frequency scale on preprinted recording paper. See section 4.1.2.

2.3. SIDE PANEL

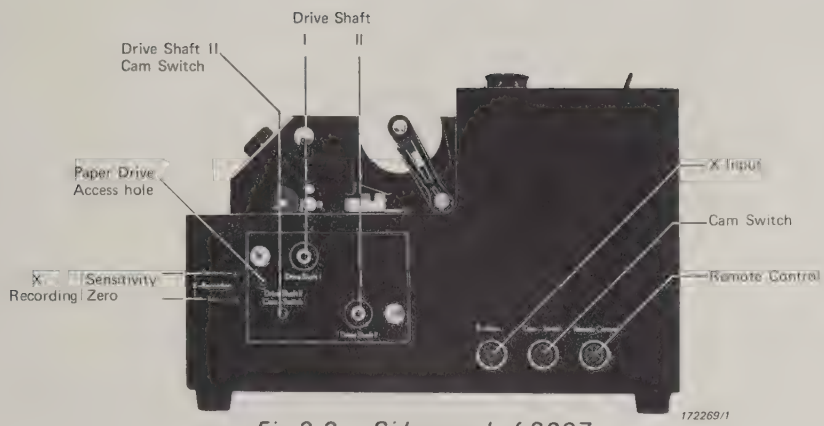


Fig.2.3. Side panel of 2307

REMOTE CONTROL:

7-pin DIN socket with Event Marker, Pen Lift, Automatic Stop and Manual Stop remote control lines, plus lines for automatic switching of the third octave filters of B & K Filter Sets and Frequency Analyzers. For connections see Fig.2.4.

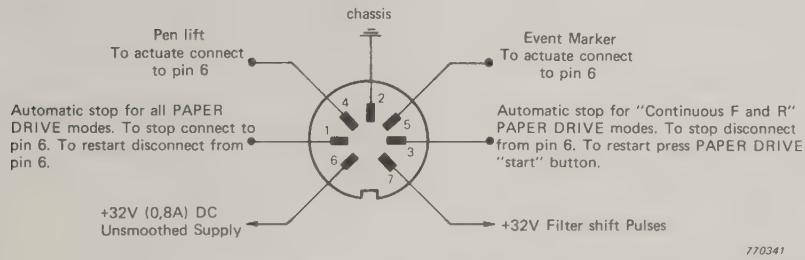


Fig.2.4. External view of REMOTE CONTROL socket

CAM SWITCH:

8-pin DIN socket with make/break switch contacts activated by a cam on DRIVE SHAFT II. It may be used to switch two microphone channels for multiplexed recording as in section 4.5 as well as to activate the pen lift facility for dashed line recording as in section 4.6. For connections see Fig.2.5.

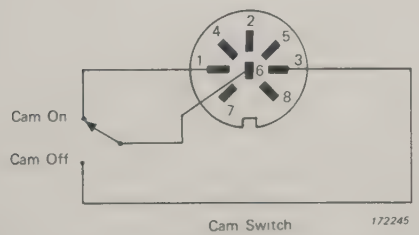


Fig.2.5. External view of CAM SWITCH socket showing internal switch connections

X INPUT:

8-pin DIN socket accepting an external DC ramp voltage for remote control of the forward and reverse movement of the recording paper when the PAPER DRIVE FUNCTION selector is set to "X-Rec". For connections and further information on the use of this socket see section 4.2.

DRIVE SHAFT I & II:

Two drive shaft sockets accepting a Flexible Drive Shaft UB 0041 for remote tuning of B & K Signal Generators and Frequency Analyzers. DRIVE SHAFT I is for synchronizing the frequency scales of external instruments with preprinted charts, whilst DRIVE SHAFT II is for expanding or contracting these frequency scales.

X RECORDING:

Two 25-turn screwdriver operated potentiometers with the following functions:

"Sensitivity". Adjusts "X Rec" mode paper drive sensitivity from 15 to 50 mm/V.

"Zero". Adjusts "X Rec" mode paper start position over entire 250 mm chart length.

DRIVE SHAFT II CAM SWITCH:

Mechanical screw head adjustment for moving the CAM switch follower on and off the cam disc mounted on DRIVE SHAFT II. The respective positions of the white spot are 6 o'clock for the follower "On" and 12 o'clock for the follower "Off". In the "Off" position the contacts between pin 6 and pin 3 of the CAM SWITCH socket are closed. See Fig.2.5.

PAPER DRIVE:

Access hole to paper drive for fastening 6 mm diameter drive spindle for external control of paper movement when the motor and drive gears of the Recorder are removed from the paper drive mechanism. See section 3.2.1.

2.4. REAR PANEL

INPUT:

DC coupled input accepting a BNC coaxial plug (B & K No. JP 0035) for application of the signal to be recorded. Is connected in parallel with the signal INPUT socket on the front panel of the Recorder.

REMOTE CONTROL:

7-pin DIN socket connected in parallel with the REMOTE CONTROL socket on the side panel of the Recorder. For connections see Fig.2.4.

MAINS INPUT:

Input socket accepting the Power Cable AN 0010 provided for connection of an AC mains supply. Before connecting a supply the mains voltage setting and fuse checks given in section 3.2 should be carried out.

3. OPERATION

3.1. MOUNTING

The Level Recorder Type 2307 may be used free standing on its four plastic feet or, for a more permanent laboratory installation, it may be mounted together with other B & K instruments using one of the instrument combining units mentioned in Chapter 1. Also mentioned are remote control cables and a chain drive for automatic frequency scanning when using B & K Signal Generators and Frequency Analyzers with the Recorder.

3.2. MAINS CHECKS AND CONNECTIONS

The 2307 may be powered from a 100; 115; 127; 220 and 240 V ± 10% (50 or 60 Hz) single phase AC mains lines. Before connecting a mains supply the following checks and adjustments should be carried out to ensure safe operation of the apparatus.

3.2.1. Frequency Setting

For operation of the 2307 from 50 and 60 Hz mains lines the motor and drive gears of its paper drive mechanism must have the correct gear ratio. The gears are shown in Fig.3.1 and are accessible on removing the drive shaft panel on the right-hand side of the Recorder. This is fastened by two screws which need only be given half a turn to release the panel.

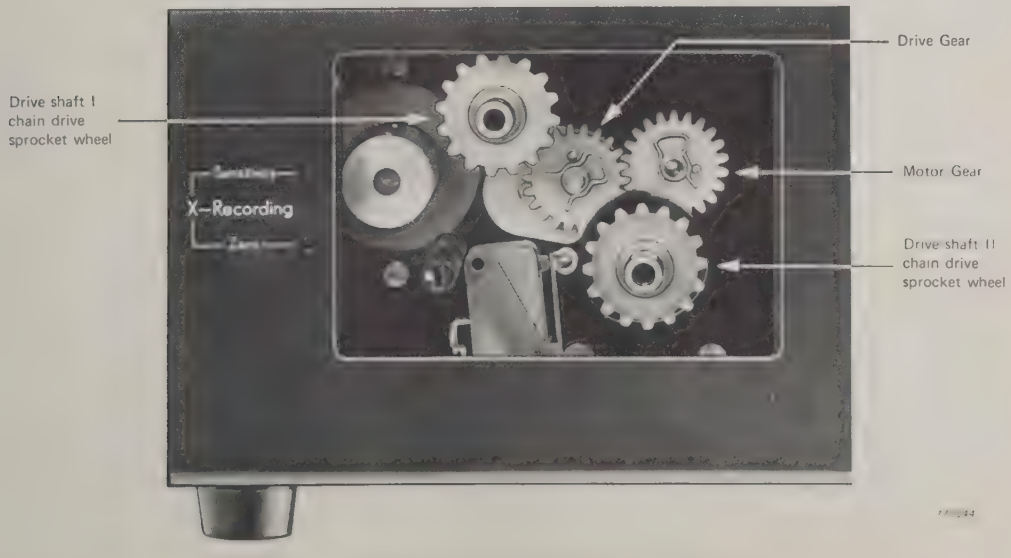


Fig.3.1. Paper drive mechanism of the 2307

For 50 Hz supplies two gears with 22 teeth (B & K No. DG 0233) should be fitted, whilst for 60 Hz supplies a motor gear with 20 teeth (B & K No. DG 0232) and drive gear with 24 teeth (B & K No. DG 0234) should be used. The gears are made of nylon and are fastened by spring clips. They may be replaced by the appropriate types after unscrewing the sprocket wheel from drive shaft II and pulling it out together with the cam disc on the same spindle. The DRIVE SHAFT II SPEED knob should be set to "0,0036" rpm so that the drive mechanism does not rotate when unscrewing the sprocket wheel.

3.2.2. Voltage Setting

The mains voltage setting of the 2307 is displayed in the window of the VOLTAGE SELECTOR on its top panel. To select the correct mains voltage setting unscrew the knob at the centre of the selector and pull it as well as the black bush behind the knob, straight out. Replace the bush so that its pin fits into the slot immediately opposite the correct mains voltage setting which should now appear in the window of the bush.

3.2.3. Fuse Rating

The mains fuse is contained in the knob at the centre of the VOLTAGE SELECTOR. For operation from 100; 115; and 127 V lines the fuse should be a 1 A slow blow (B & K No. VF 0013), whilst for 220 and 240 V lines it should be a 630 mA slow blow (B & K No. VF 0032). Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short circuiting of fuse holders should be avoided.

3.2.4. Supply Connections

Once the mains voltage setting and fuse have been checked the mains line may be connected to the MAINS INPUT socket of the Recorder using the Power Cable AN 0010 provided. To fit a suitable mains plug to the cable, see Fig.3.2.

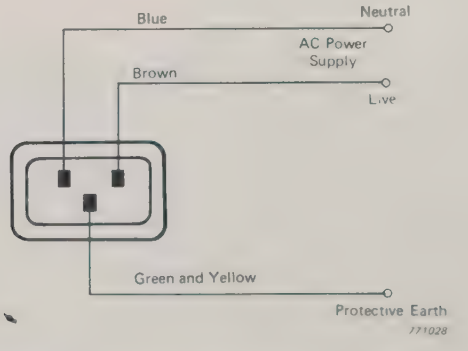


Fig.3.2. Connection of mains supply to MAINS INPUT socket of 2307

For maximum operating safety it is recommended that the protective (green/yellow) conductor of the cable be connected to a suitable earth such as the protective earth conductor of a mains socket outlet. The use of an extension cable without protective conductor should be avoided. In countries where the use of a mains socket outlet without protective conductor is standard, the mains supply should incorporate an authorized earth leakage current circuit breaker.

3.3. RANGE POTENTIOMETER SELECTION AND INSTALLATION

The dynamic range corresponding to one recording chart width is determined by the POTENTIOMETER RANGE switch setting of the Recorder and the Range Potentiometer fitted. Commonly used POTENTIOMETER RANGE switch settings for the two linear and four logarithmic Range Potentiometers available are given in Table 3.1.

Range Potentiometer Type		ZR 0001 Lin	ZR 0002 Lin	ZR 0003 10 dB Log	ZR 0004 25 dB Log	ZR 0005 50 dB Log	ZR 0006 75 dB Log
Potentiometer Range switch setting on 2307		"12 dB"	"16 dB"	"10 dB"	"25 dB"	"50 dB"	"80 dB"
Min* Input Voltage	Zero deflection	5 mV	5 mV	50 mV	5 mV	5 mV	5 mV
	Full scale deflection	17,5 mV	55 mV	160 mV	90 mV	1,6 V	28 V
Max.** Input Voltage		54 V	100 V	100 V	100 V	100 V	100 V
INPUT ATTENUATOR and POTENTIOMETER controls set *fully clockwise **fully anticlockwise							

770428

Table 3.1. Recording range as a function of Range Potentiometer and POTENTIOMETER RANGE switch setting of the 2307

To change a Range Potentiometer set the PEN DRIVE switch to "Off" and slide the writing pen holder L shown in Fig.3.3 to the extreme right of its travel (zero deflection). With the pen holder situated near the pen lift cam H, unscrew the knob on top of the Range Potentiometer and lift it out of its recess in the Recorder. Slide the Range Potentiometer required for recording into the recess and screw it down so that it is flush with the top panel of the Recorder.

WARNING: Under no circumstances should the writing pen holder be left near the extreme left of its travel (full scale deflection) as otherwise the contact slider in the potentiometer compartment of the Recorder will be damaged when the Range Potentiometer is inserted. Similarly, never bend the contact slider as this will seriously impair the correct function of the Recorder. For protection from dust and other foreign matter, never

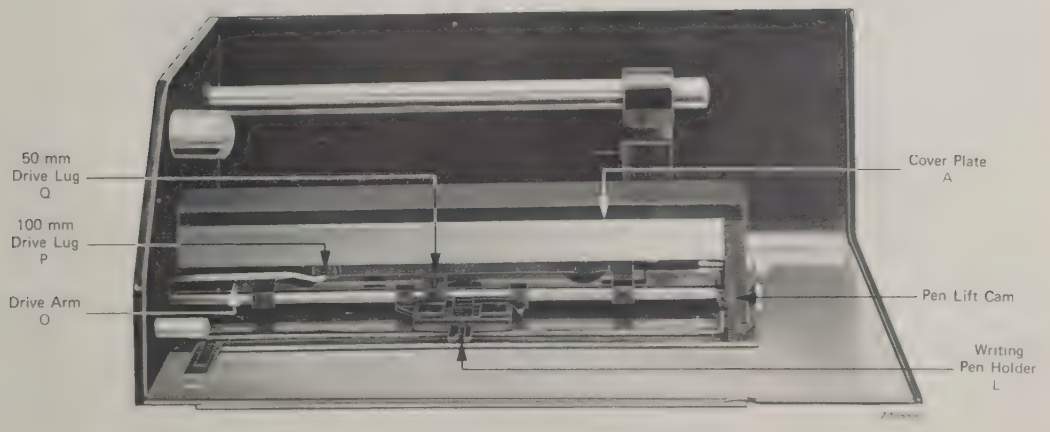


Fig.3.3. Writing system of the 2307

leave the Recorder without a Range Potentiometer fitted and always ensure that Range Potentiometers not in use are kept in their storage boxes.

3.4. LOADING RECORDING PAPER

The 2307 accepts the types of recording paper shown in Chapter 1. Rolls of recording paper for strip and rectilinear chart recording have 50 and 100 mm writing widths, whilst polar charts have a 100 mm writing radius.

3.4.1. Selection of 50 and 100 mm Writing Width

For selection of 50 and 100 mm writing widths a view of the writing system of the 2307 is shown in Fig.3.3.

1. Remove the stainless steel cover plate A of the writing system shown in Fig.3.3.

2. Set the PEN DRIVE switch to "Off" and slide the writing pen holder L to the extreme left of its travel (full scale) so that the drive lugs P and Q are immediately opposite each other.

3. Using a small screwdriver or a pair of tweezers, push the ball joint on the end of the drive arm O from the socket of one drive lug to the next. Drive lug Q is for 50 mm writing, whilst drive lug P is for a 100 mm.

4. Replace the stainless steel cover plate ready for loading the recording paper.

3.4.2. Loading Recording Chart Rolls

A view of the Recorder's writing system with roll of recording paper fitted, is shown in Fig.3.4. To load the paper proceed as follows:

1. Lift the writing pen holder L clear of the writing plate by rotating the pen lift cam H shown in Fig.3.4.

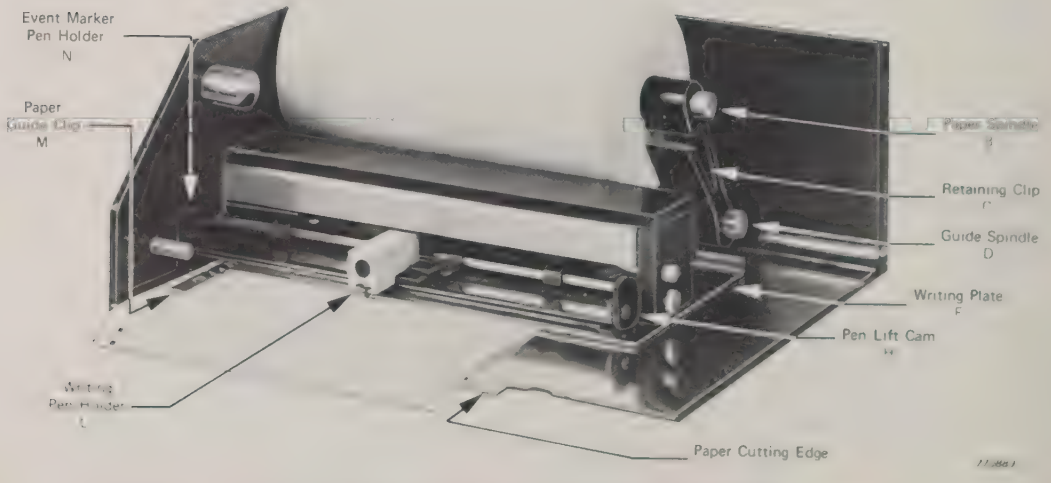


Fig.3.4. Writing system of the 2307 with roll of rectilinear recording paper

2. Squeeze the spring loaded paper retaining clip C and slide it off the paper spindles B and D.

3. Take a roll of recording paper in the right hand and with the left hand pull out a length of approximately 30 cm (12 in). Holding the paper thus, slide it under the writing plate F, around spindle D and at the same time mount the roll on spindle B. Slide the roll to the left until it is stopped by the paper drive sprocket wheel guide clip M. Lift the guide clip up and slip the sprocket holes in the paper over the sprocket wheel. Make sure they are properly engaged and release the guide clip M.

4. Replace the retaining clip, making sure that the paper passes between spindle D and the lip of the retaining clip. Leave about 1 mm clearance between the retaining clip and the roll of paper as otherwise the paper will tear at the sprocket holes.

5. Check that the paper feed is free by manually rotating the PAPER ADJUSTMENT wheel on the front of the Recorder.

3.4.3. Loading Polar Charts

A view of the Recorder's writing system with polar recording chart fitted, is shown in Fig.3.5. To fit a polar chart proceed as follows:

1. Lift the writing pen holder L clear of the writing plate by rotating the knurled paper lift cam H shown in Fig.3.5.

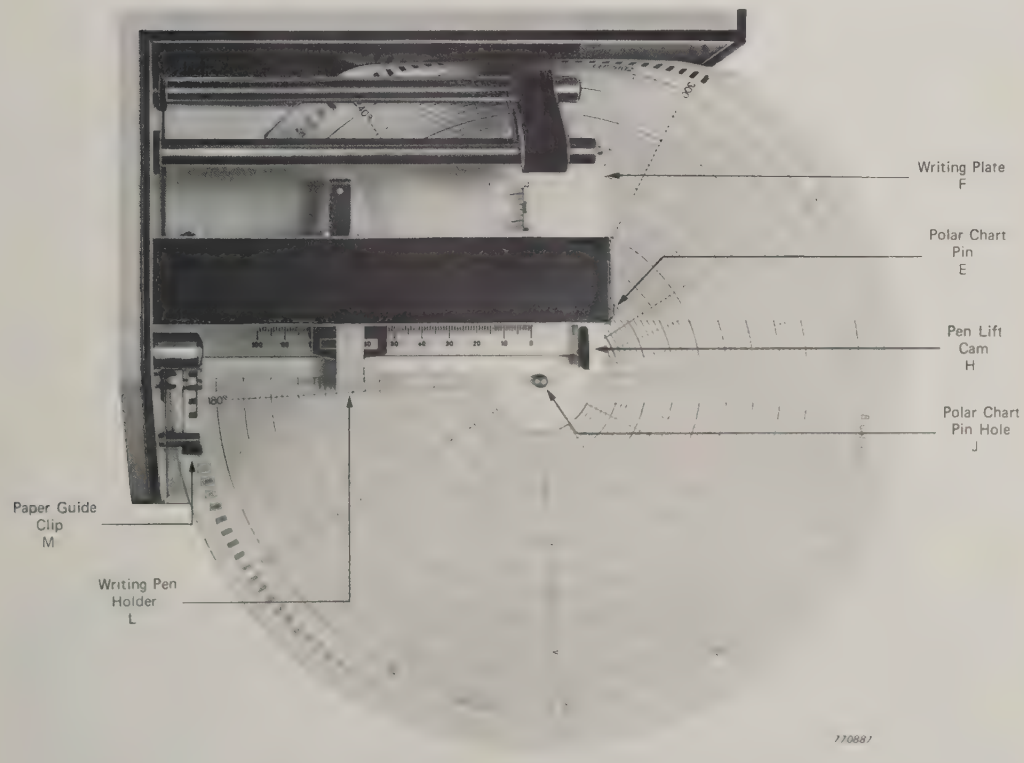


Fig.3.5. Writing system of the 2307 fitted with a polar recording chart

2. Slide the polar chart under the writing plate F until it is stopped by the paper drive sprocket wheel guide clip M. Lift the guide clip and slip the sprocket holes in the paper over the sprocket wheel. Make sure that they are properly engaged before releasing the guide clip.

3. Locate the hole in the centre of the polar paper over the hole J in the writing plate and insert the pin E. The pin is normally stored beside the pen lift cam when not in use.

4. Check that the paper feed is free by manually rotating the PAPER ADJUSTMENT wheel on the front of the Recorder.

3.4.4. Paper Cutting Edge

A paper cutting edge is provided along the front edge of the writing plate shown in Fig.3.6. This is intended for cleanly tearing off chart lengths and may be pushed out from its retracted position by inserting a small coin in the circular recess at the edge of the writing plate.

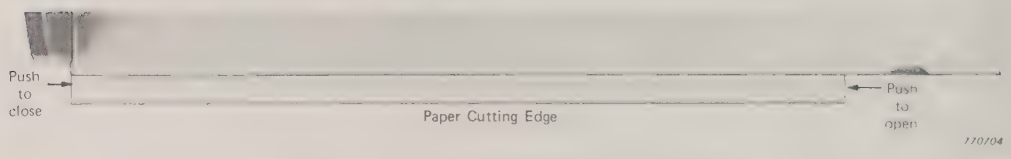


Fig.3.6. Paper cutting edge of the 2307

3.5. INSTALLATION OF PENS AND STYLI

The event marker pen holder N and writing pen holder L shown in Fig.3.4 accept disposable fibre pens and ink cartridge pens for writing on white recording paper, as well as sapphire slyli for writing on white wax coated paper. They may be mounted on the pen holders simply by sliding them on from the front as shown in Fig.3.7.

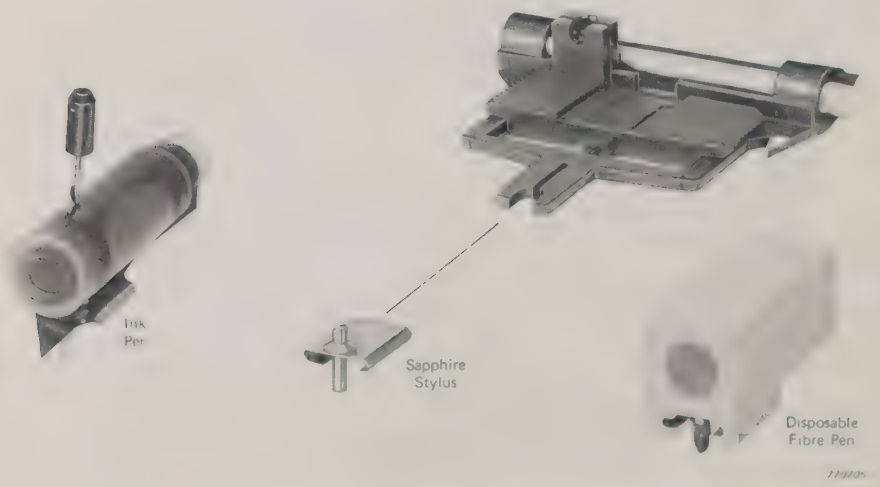


Fig.3.7. Mounting pens and styli onto pen holder

3.5.1. Loading Ink Cartridges

1. Remove the cleaning needle from the centre of the ink feed tube of the cartridge holder.

2. Place the lug at the rear end of the cartridge holder into the recess at the thin end of the ink cartridge as shown in Fig.3.8(a). Holding them in the position shown pierce the outer wall of the cartridge at its air lock, with the sharp end of the ink feed tube of the cartridge holder.

3. Turn the cartridge over as shown in Fig.3.8(b) and pierce the opposite wall of the cartridge at its air lock.

Fig.3.8. Mounting ink cartridge onto cartridge holder

4. Push the ink feed tube through the cartridge until the cartridge holder lies parallel with the cartridge.

5. Insert the cleaning needle in the feed tube and push it up and down until a small drop of ink appears at the end of the tube.

6. Keeping the cleaning needle inserted fit the pen cartridge onto the event marker or writing pen holder as shown in Fig.3.7.

   WARNING: To prevent leakage the ink cartridge should always be pierced at the top where the air lock is.

3.5.2. Pen Pressure Adjustment

The writing pen holder shown in Fig.3.9 is equipped with a small magnet. By gripping the serrated nail grips on either side of the holder the magnet may be moved along a

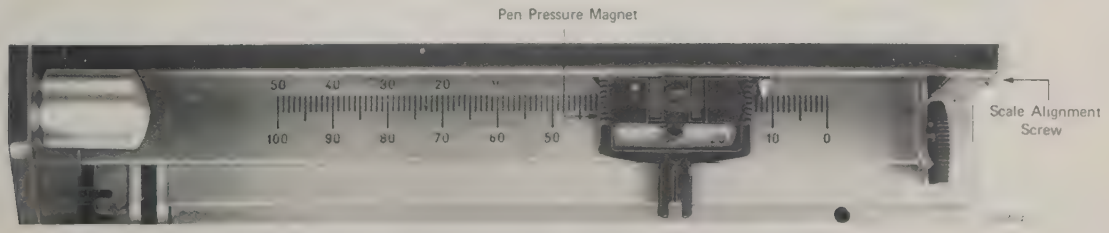


Fig.3.9. Pen pressure adjustment magnet and pen alignment scale of the 2307

four stop ratchet towards the front or rear of the holder. This alters the relative attraction between the magnet and the writing plate thus changing the writing pressure. Maximum writing pressure is obtained with the magnet at the front of the holder.

3.5.3. Pen Alignment

To aid pen alignment a graduated steel scale is mounted immediately beneath the writing pen holder as shown in Fig.3.9. To correctly align the scale with the level graduations marked on the recording paper, move the pen to the very topmost line on the paper, and adjust the screw at the side of the writing system until the 100 mm line marked on the scale coincides with the white arrow on the pen holder. To move the pen to the required position by hand, set the PEN DRIVE switch to "Off".

3.6. LOWER LIMITING FREQUENCY AND WRITING SPEED SELECTION

To ensure stable operation of the writing system of the 2307 it is important that the correct combination of LOWER LIMITING FREQUENCY and WRITING SPEED setting be selected on the Recorder. For recording of DC signals using the "DC" RECTIFIER RESPONSE switch mode of the Recorder, the LOWER LIMITING FREQUENCY and WRITING SPEED switches should be set to "200 Hz" and "1000 (2000)" mm/s respectively. If overshoot is considered a problem with very fast moving DC signals then a slower WRITING SPEED setting may be selected without introducing instability.

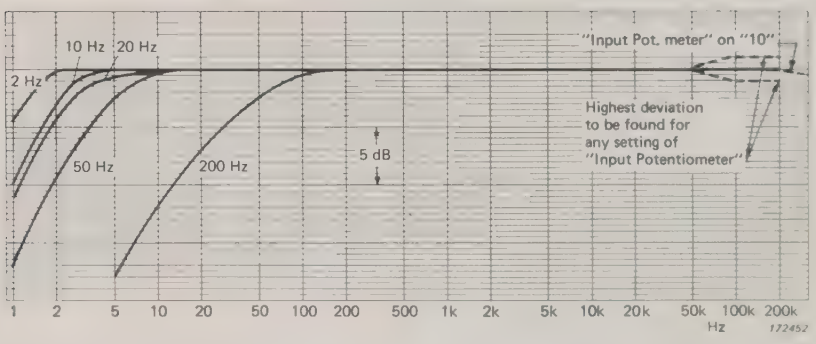


Fig.3.11. Influence of LOWER LIMITING FREQUENCY and INPUT POTENTIOMETER controls on the frequency response of the 2307

For recording of AC signals using the "Average", "RMS" and "Peak" modes of the RECTIFIER RESPONSE switch, the Recorder has the frequency response shown in Fig.3.11. Suitable LOWER LIMITING FREQUENCY and WRITING SPEED settings for recording AC signals are given in Fig.3.12. These are valid for use of logarithmic Range Potentiometers when the POTENTIOMETER RANGE switch settings specified in Table 3.1 are employed. When using linear Range Potentiometers with the pen operating over the lower half of its deflection range, the maximum WRITING SPEED setting must be kept two or more steps below that indicated in Fig.3.12. If this is not convenient then the POTENTIOMETER RANGE setting may be increased. This will improve stability but at the expense of reducing the resolving power of the Recorder. When operating with the pen in the upper half of its deflection range there is no need to depart from the criteria specified in Fig.3.12.

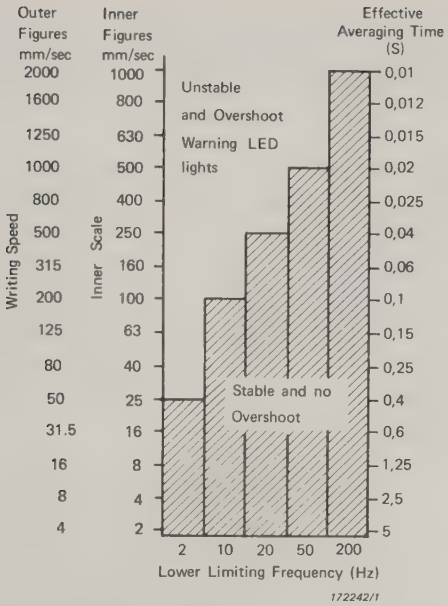


Fig.3.12. LOWER LIMITING FREQUENCY and WRITING SPEED control settings for AC recording with the 2307

Also indicated in Fig.3.12 is the effective averaging time of the Recorder's writing system. This is primarily a function of the writing speed and for AC recording influences the accuracy of the recorded signal level by determining the amount of ripple left on the signal after rectification by the Recorder.

Since averaging is performed electromechanically and not by a completely self-determined system, such as an electronic RC averager, the averaging times specified in Fig.3.12 are only approximate. Laboratory measurements reported in the B & K Technical Review No. 1 — 1974, indicate that with normal control settings of the Recorder and pen deflections of 6 to 8 mm for 50 mm (12 to 16 mm for 100 mm) writing widths there can be a ± 100% spread in the values stated. For precise averaging, valid over the entire paper width, DC recording from the output of a B & K Measuring Amplifier or Frequency Analyzer equipped with precise RC averaging time constants is to be preferred.

The writing speeds which correspond with the IEC sound level meter standards "Fast" and "Slow" meter dampings are 63 dB/s and 16 dB/s respectively. From this the Level Recorder WRITING SPEED setting corresponding to the particular Range Potentiometer in use can be calculated. For example with a 50 dB Range Potentiometer fitted the WRITING SPEED settings corresponding to "Fast" and "Slow" damping are "63 (125)" and "16 (31,5)" respectively. In most practical recording situations the respective settings are sufficient for minimizing ripple on signals with frequency components down to 20 Hz and 2 Hz respectively.

3.7. RECORDING PROCEDURE

To record AC or DC signal levels using the 2307 Level Recorder, proceed as follows:

1. Ensure that the Recorder is correctly adjusted for the mains supply and fit it with the Range Potentiometer, recording paper and pen or stylus required for recording. See sections 3.2, 3.3, 3.4 and 3.5 respectively.

2. Set the POTENTIOMETER RANGE switch in accordance with the Range Potentiometer fitted (see Table 3.1) and turn the INPUT POTENTIOMETER and INPUT ATTENUATOR fully anticlockwise.

3. Set the POWER switch "On" and select a suitable RECTIFIER RESPONSE switch function. "RMS", "Average" or "Peak" for recording AC signal levels with frequencies from 2 Hz up to 200 kHz. "DC" for recording slow and rapidly moving DC signal levels.

4. Set the LOWER LIMITING FREQUENCY and WRITING SPEED switches for a low frequency limit and effective averaging time appropriate for the signal to be recorded, that permit stable operation of the Recorder without its "decrease ws" or "increase LLF" warning LED lighting. For DC signals set the switches to "200" Hz and "1000 (2000)" mm/s respectively. For AC signals see Fig.3.12.

5. With the PAPER DRIVE FUNCTION switch set to "Continuous F" for recording over any chart length, lift up the PAPER SPEED knob and turn it to the speed required for recording.

6. Using the PAPER ADJUSTMENT wheel, adjust the position of the recording paper until the pen is immediately above the required starting point on the paper.

7. With the PEN DRIVE switch set to "On" press the 100 mV REF button on the front of the Recorder and adjust the INPUT ATTENUATOR and INPUT POTENTIOMETER so that the pen deflects to a suitable reference line on the recording paper.

   Example: If a 50 dB Range Potentiometer is fitted, set the INPUT ATTENUATOR to "0" and adjust the INPUT POTENTIOMETER until the pen deflection corresponds with the 20 dB line (third heavy line from the base of the recording paper). In this configuration the base line value in dB re 10 mV will always correspond to the INPUT ATTENUATOR setting.

   Note: For DC recording the recorder pen deflection must be calibrated using an external DC reference voltage such as is available from a B & K Measuring Amplifier or Frequency Analyzer equipped with a DC Output.

8. Apply the signal to be recorded to the INPUT socket of the Recorder and adjust the INPUT ATTENUATOR to obtain a suitable pen deflection that does not exceed full scale on the recording paper. The maximum input voltage which may be applied is 100 V RMS.

   Note: For DC recording the input signal can be of positive or negative polarity, but not both. With signals of changing polarity it is necessary to apply a positive or negative DC bias to the signal. This can be done by applying the signal to the INPUT socket of the Recorder via a battery or other low impedance DC voltage source connected in series.

9. Using the pen lift cam, lower the pen and press the PAPER DRIVE "Start" button to commence recording. To stop recording press the PAPER DRIVE "Stop" button

4. AUTOMATIC RECORDING AND FREQUENCY SCANNING

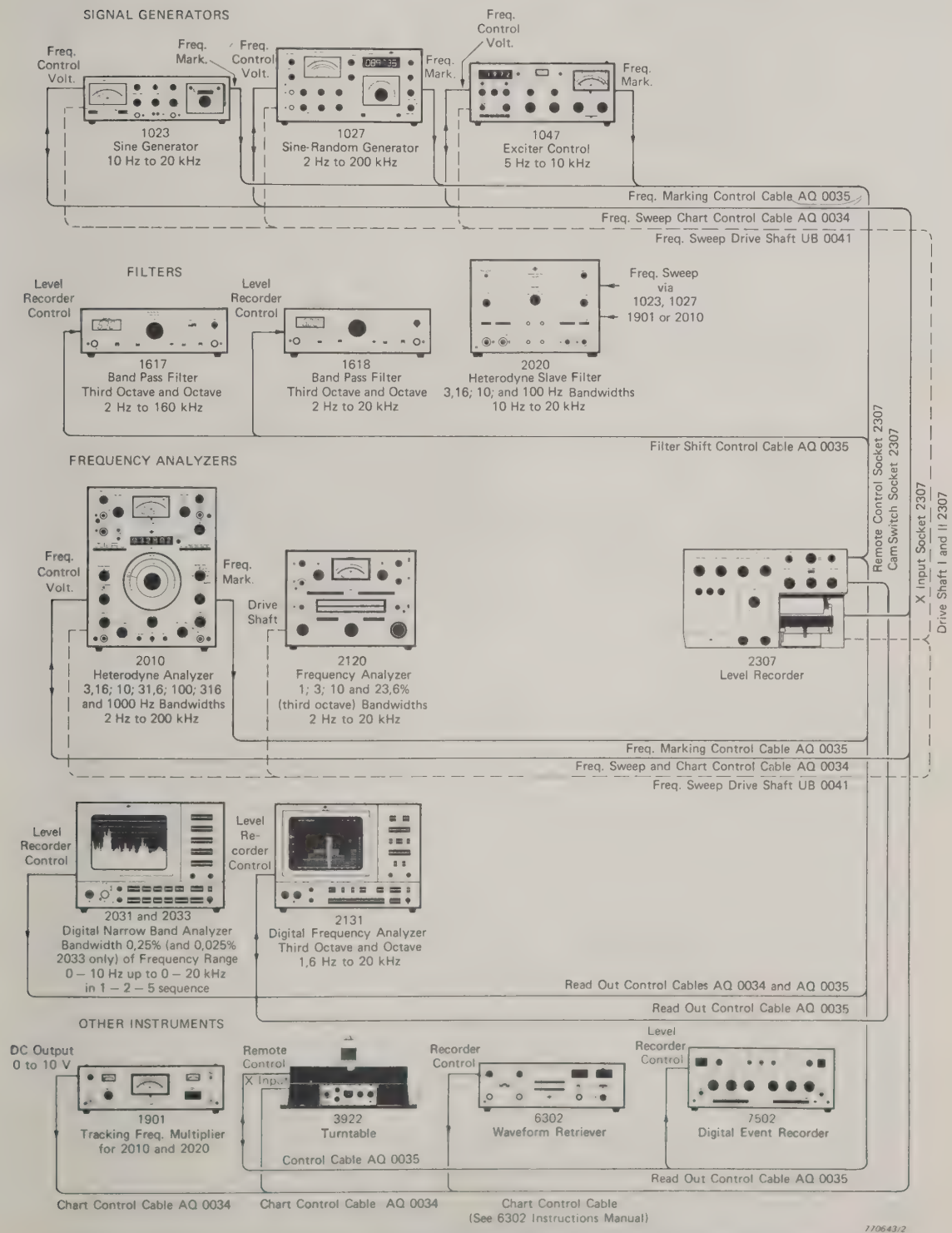


Fig.4.1. B & K instrumentation and control cables for use with the 2307 Level Recorder

4.1. SINGLE CHART RECORDING

For automatic recording of frequency responses and analyses over a fixed 250 mm chart length, the 2307 has an automatic stop function plus remote control facilities for automatic frequency scanning of the Signal Generators, Filter Sets and Frequency Analyzers shown in Fig.4.1. The setting up procedure for synchronizing the Recorder with these instruments depends on the type of frequency scan.

4.1.1. Continuous Mechanical Scanning

With B & K Signal Generators and Frequency Analyzers that accept the flexible Drive Shaft UB 0041, remote frequency scanning may be accomplished using DRIVE SHAFTS I and II of the Level Recorder. DRIVE SHAFT I is used for obtaining a synchronous frequency scan corresponding with the frequency scale of preprinted recording paper, whilst DRIVE SHAFT II is for obtaining a frequency scan over a compressed or expanded frequency scale on level graduated paper without frequency graduations. The rotation of DRIVE SHAFT I is determined by the setting of the PAPER SPEED knob of the Recorder, whilst that of DRIVE SHAFT II is determined by the setting of the DRIVE SHAFT II SPEED knob and is independent of paper speed.

The setting up procedure for synchronizing the frequency scan is given below. This is for scanning over a logarithmic frequency scale and uses preprinted recording paper with logarithmic frequency scale graduations. For scanning over a linear frequency scale a similar procedure may be used, but with level graduated recording paper without frequency graduations. In this case the frequency marker facility provided with most B & K Signal Generators and Frequency Analyzers may be used to operate the event marker pen of the recorder. See Fig.2.4.

1. On the Signal Generator or Frequency Analyzer set controls:

POWER	"On"
SCANNING CONTROL or FILTER TUNING	"Ext. Mech."

2. On the Level Recorder set controls:

POWER	"On"
PAPER DRIVE FUNCTION	"Continuous F"
PAPER SPEED	"10 mm/s"
DRIVE SHAFT II SPEED	"12 rpm"

3. Press the PAPER DRIVE "Start" button on the Level Recorder and screw one end of the flexible Drive Shaft into DRIVE SHAFT I or II socket. When correctly coupled the inner part of the shaft should begin to rotate.

4. Screw the other end of the Flexible Drive Shaft into the DRIVE SHAFT socket on the left side panel of the Signal Generator or Frequency Analyzer. When correctly coupled the frequency scale pointer of the instrument should start to move.

5. Press the PAPER DRIVE "Stop" button on the Level Recorder and load a roll of recording paper with preprinted frequency scale suited to the particular Signal Generator or Frequency Analyzer employed. See section 3.4.2.

6. Turn the PAPER ADJUSTMENT and AUTOMATIC STOP wheels so that the white spots marked on the wheels coincide and that these appear near the top of the opening on the front of the Recorder.

7. With the PAPER DRIVE FUNCTION switch set to "Automatic Stop F", press the PAPER DRIVE "Start" button and wait until the paper drive stops automatically.

8. Lift up the guide clip above the paper drive sprocket wheel and move the recording paper so that the required starting frequency on the chart is directly (or as near as possible) under the pen.

9. If the pen lies just before (or just after) the required starting frequency on the paper, turn the AUTOMATIC STOP wheel so that its white spot is a corresponding distance above (or below) the white spot on the PAPER ADJUSTMENT wheel. The range of adjustment is 12,5 mm.

10. Push the PAPER ADJUSTMENT wheel so that its white spot appears near the top of the opening on the front of the Recorder and press the PAPER DRIVE "Start" button. The paper drive should stop automatically with the pen over the required start frequency on the chart. If not, repeat items 9 and 10.

11. Set the SWEEP CONTROL or FREQUENCY TUNING switch of the Signal Generator or Analyzer to "Manual" and turn the FREQUENCY TUNING knob so that the frequency scale pointer is set to the required starting frequency corresponding with that to which the pen is set on the paper.

12. Set the SCANNING CONTROL or FILTER TUNING switch back to its "Ext. Mech." mode, ready for recording.

The Level Recorder and Signal Generator or Frequency Analyzer are now synchronized. When DRIVE SHAFT I is used for frequency scanning any PAPER SPEED knob setting may be selected without losing synchronization. To retain synchronization when DRIVE SHAFT II is used the DRIVE SHAFT II SPEED and PAPER SPEED knobs must be set to the same angular settings.

4.1.2. Stepped-Electrical Scanning

With B & K Band Pass Filters which have discrete octave and third-octave filters, the filters may be switched remotely using the filter shift pulses which are available at the REMOTE CONTROL socket of the Level Recorder. For synchronous switching of the filters, corresponding with the frequency scale of pre-printed recording paper, proceed as follows:

1. Load the Level Recorder with a roll of preprinted recording paper with logarithmic frequency scale suited to the particular Band Pass Filter employed. See section 3.4.2.

2. On the Level Recorder set controls:

POWER	"On"
PAPER DRIVE FUNCTION	"Continuous F"
PAPER SPEED	"10 mm/s" not "1 cm/s"
PEN DRIVE	"Off"

and move the pen to full scale on the recording chart.

3. Connect the REMOTE CONTROL sockets of the Level Recorder and Band Pass Filter with the appropriate Filter Shift cable indicated in Fig.4.1, and set controls on the Band Pass Filter as follows:

SELECTIVITY	"Bandwidth" and "Record Step" as required
RANGE	to appropriate filter centre frequency range required for analysis
FILTER CONTROL MODE	"Recorder"
MANUAL FILTER SELECTOR	to centre frequency of octave or third octave band in which analysis is to commence
AVERAGING TIME (rear panel of 1617)	"Fixed"
POWER	"On"

4. Turn the PAPER ADJUSTMENT and AUTOMATIC STOP wheels of the Recorder so that the white spots marked on the wheels coincide and appear near the top of the opening on the front of the Recorder. Press the PAPER DRIVE "Start" button and wait until the paper drive stops automatically.

5. Lift up the guide clip above the paper drive sprocket wheel and pull the recording paper forward to a position where the pen is approximately 2,5 mm (third octave) or 7,5 mm (octave) before the centre frequency marking ▼ corresponding with the centre frequency of the third octave or octave frequency band in which analysis is to commence. The centre frequency markings ▼ are placed at 5 mm intervals along the top most line of the chart.

6. If the pen lies just before (or just after) the correct starting point on the paper, turn the AUTOMATIC STOP wheel so that its white spot is a corresponding distance above (or below) the white spot on the PAPER ADJUSTMENT wheel. The range of adjustment is ± 12,5 mm.

7. Push the PAPER ADJUSTMENT wheel upwards so that the white spot appears near the top of the opening on the front of the Recorder, and press the PAPER DRIVE "Start" button. The paper drive should stop automatically with the pen over the correct starting point for recording. If not repeat items 6 and 7.

8. Set the PAPER DRIVE FUNCTION switch on the Recorder to "Stop" and on the Band Pass Filter momentarily press the right hand FILTER CONTROL MODE switch to "Run".

9. Slowly rotate the FILTER SHIFT WHEEL of the Recorder downwards until the digital display of the Band Pass Filter indicates a change in filter centre frequency. Rotate the wheel a further distance just short of 5 mm downwards.

10. Set the FILTER CONTROL MODE switch on the Band Pass Filter to "Stop" and the PAPER DRIVE FUNCTION and PEN DRIVE switches of the Recorder to "Continuous F" and "On" respectively.

    The paper position is now synchronized with the filter switching. Do not readjust the PAPER ADJUSTMENT, AUTOMATIC STOP or FILTER SHIFT wheels as synchronization will be lost. Also remember that the PAPER SPEED slider switch must be set to "mm/s" as otherwise the filter shift pulses will be disconnected in the Recorder.

11. To commence recording momentarily press the right hand FILTER CONTROL MODE switch of the Band Pass Filter to "Run". This will actuate the paper drive and filter switching. On completion of the recording the Band Pass Filter will return to the required start frequency and the paper drive will stop at the correct start position on the next chart.

4.1.3. Continuous Electrical Scanning

With B & K Signal Generators and Frequency Analyzers that accept Sweep Control Cables, remote voltage controlled frequency scanning is possible. This is accomplished via the X INPUT socket of the Level Recorder which when connected to a Generator or Analyzer produces a remote control ramp with voltage proportional to the position of the recording chart over one complete 250 mm chart length. The ramp is derived from a fixed reference voltage in the Generator or Analyzer which is applied to a position reference potentiometer in the paper drive mechanism of the Level Recorder.

For remote voltage controlled frequency scanning of non B & K Generators and Analyzers a positive or negative slope control voltage ramp may be derived using the X INPUT socket connections shown in Fig.4.2. These connect the position reference potentiometer to a reference voltage source in the Recorder. For positive and negative slope ramps the maximum ramp voltage is + 15 and —7 V respectively depending on the setting of the X RECORDING SENSITIVITY and X RECORDING ZERO potentiometers of the Recorder.

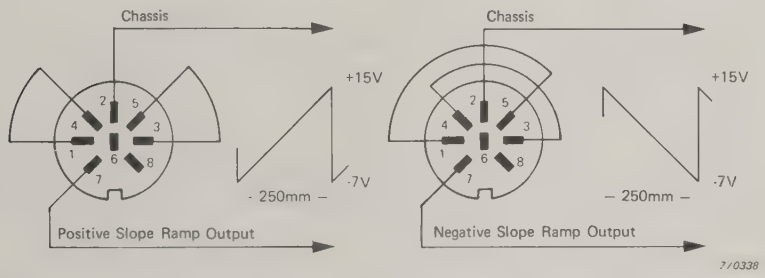


Fig.4.2. External connections to the X INPUT socket of the 2307 for a positive or negative slope, remote control voltage ramp proportional to the position of the recording chart

The setting up procedure for synchronizing the frequency scan is given below. This is for scanning over a logarithmic frequency scale and uses preprinted recording paper with logarithmic frequency scale graduations. For scanning over a linear frequency scale a similar procedure may be used, but with level graduated recording paper without frequency graduations. In this case the frequency marker facility provided with most B & K Signal Generators and Frequency Analyzers may be used to operate the event marker pen of the recorder. See Fig.2.4.

1. On the Level Recorder set controls:

POWER	"On"
PAPER DRIVE FUNCTION	"Automatic Stop F"
PAPER SPEED	"10 mm/s"

   and load it with a roll of preprinted recording paper with frequency scale suited to the particular Signal Generator or Frequency Analyzer employed. See section 3.4.2.

2. Turn the PAPER ADJUSTMENT and AUTOMATIC STOP wheels so that the white spots marked on the wheels coincide and appear near the top of the opening on the front of the Recorder.

3. Press the PAPER DRIVE "Start" button and wait until the paper drive stops automatically.

4. Using the relevant sweep control cable indicated in Fig.4.1 connect the FREQUENCY CONTROL VOLTAGE INPUT socket of the Generator or Analyzer to the X INPUT socket of the Recorder.

   With non B & K Generators and Analyzers connect their REMOTE CONTROL VOLTAGE INPUT socket to the X INPUT of the Recorder using the appropriate connections shown in Fig.4.2. Then, using the polar chart pin (E in Fig.3.5) as a screwdriver, turn the X RECORDING SENSITIVITY potentiometer 25 turns clockwise and the X RECORDING ZERO potentiometer 25 turns anticlockwise.

5. With the SWEEP CONTROL switch of the Generator or Analyzer set to "Manual", turn the FREQUENCY TUNING knobs of the instrument until its digital display indicates the start frequency at the beginning of the selected frequency range.

6. Lift up the guide clip above the paper drive sprocket wheel of the Recorder and move the recording paper so that the frequency on the chart, corresponding with the start frequency in item 5, is directly (or as near as possible) under the pen.

7. If the pen lies just before (or just after) the required starting frequency on the chart, turn the AUTOMATIC STOP wheel so that its white spot is a corresponding distance above (or below) the white spot on the PAPER ADJUSTMENT wheel. The range of adjustment is ± 12,5 mm.

8. Push the PAPER ADJUSTMENT wheel upwards so that its white spot appears near the top of the opening on the front of the Recorder and press the PAPER DRIVE "Start" button. The paper drive should stop automatically with the pen over the correct start frequency on the chart. If not, repeat items 7 and 8.

9. Set the SWEEP CONTROL switch on the Generator or Analyzer to "Ext. Voltage". The digital display of the instrument should continue to indicate the required starting frequency. With B & K Generators or Analyzers it may be necessary to adjust the FREQUENCY INCREMENT or SCALE ALIGNMENT knob to obtain the correct indication. With non B & K Generators and Analyzers this can be done using the polar chart pin to turn the X RECORD ZERO potentiometer clockwise.

10. Turn the PAPER ADJUSTMENT wheel so that the paper is moved forward to a point where the pen is directly over the required finishing frequency on the chart and check that the digital display of the Generator or Analyzer indicates the same frequency. If not it will be necessary to adjust the Recorder remote control voltage until the required indication is obtained.

    With B & K Generators and Analyzers the remote control voltage may be adjusted using the preset potentiometer shown in Fig.4.3. This is located in the front right hand corner of the Recorder and is accessible on removing the bottom panel which is fastened by three screws. For safety disconnect the mains supply when removing or replacing the panel.

    With non-B & K Generators and Analyzers the remote control voltage may be adjusted using the polar chart pin to turn the X RECORDING SENSITIVITY potentiometer anticlockwise until the required frequency indication is obtained.

11. Press the PAPER DRIVE "Start" button so that the paper is moved forward to the next chart where it should stop automatically at the correct starting frequency for recording. If not, repeat items 7 to 11 to obtain correct synchronization.

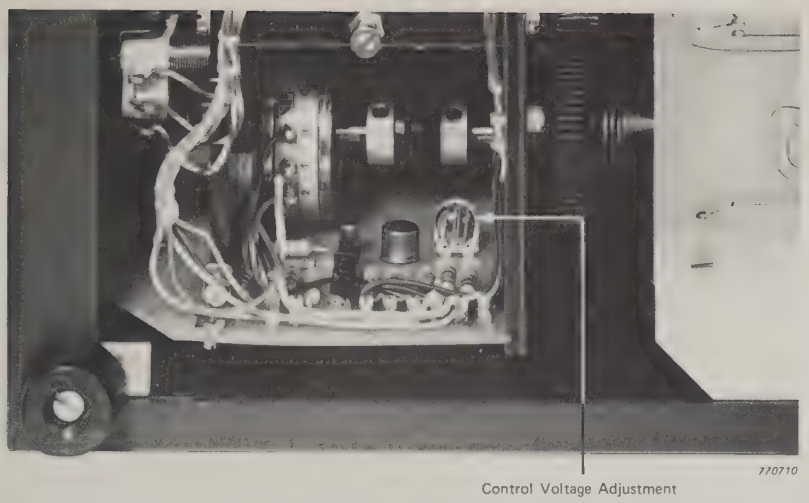


Fig.4.3. Preset potentiometer for adjustment of control voltage ramp of 2307

4.2. X RECORDING

Many of the B & K measuring and analyzing instruments shown in Fig.4.1, which accept chart control cables, produce a control voltage ramp proportional to their sweep period or frequency. When applied to the X INPUT socket of the 2307 this may be used to control the forward and reverse movement of the recording paper. The Recorder then behaves in a similar manner to an X—Y recorder, enabling synchronous recordings of signal waveforms, polar plots, frequency responses and analyses to be made over a 250 mm chart length.

The X-record paper drive facility of the 2307 may also be used with other instruments that produce a control voltage ramp. For forward and reverse paper drive over one complete 250 mm chart length, ramps with voltages from —5 to + 5 V DC up to —20 to + 20 V DC may be applied. The relevant X INPUT socket connections for both positive and negative slope ramps are shown in Fig.4.4.

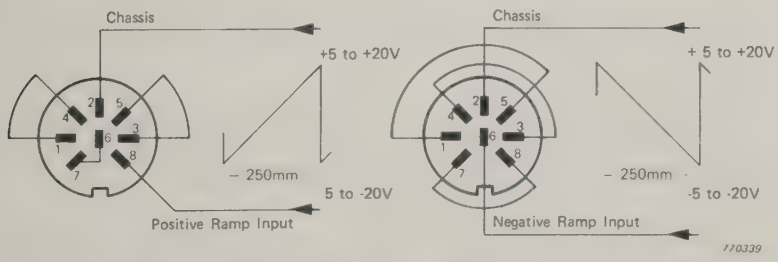


Fig.4.4. External connections to X INPUT socket of the 2307 for control of paper drive using an external control voltage ramp with positive or negative slope

The procedure for synchronizing the X paper drive of the Recorder is given below. This is for Signal Generators and Frequency Analyzers with a logarithmic frequency sweep and uses preprinted recording paper graduated with a logarithmic frequency scale. For instrumentation with a linear (frequency or time) sweep, a similar procedure may be used, but

with level graduated recording paper without frequency graduations. In this case the frequency marker facility that is provided with most B & K Signal Generators and Frequency Analyzers, may be used to operate the event marker pen of the Recorder. See Fig.2.4.

1. On the Level Recorder set controls:

POWER	"On"
PAPER DRIVE FUNCTION	"X-Rec"
PAPER SPEED	"3 cm/s

   and load it with a roll of recording paper with preprinted frequency scale suited to the particular Signal Generator or Frequency Analyzer employed. See section 3.4.2.

2. Using the relevant sweep control cable indicated in Fig.4.1 connect the FREQUENCY CONTROL VOLTAGE OUTPUT socket of the Generator or Analyzer to the X INPUT socket of the Recorder.

3. With the SWEEP CONTROL switch of the Generator or Analyzer set to "Manual", turn the FREQUENCY TUNING knobs of the instrument until its digital display indicates the required start frequency for the sweep.

4. Turn the PAPER ADJUSTMENT wheel of the Recorder so that the paper is moved forward one complete 250 mm chart length, to a point where the pen is over the required start frequency on the next chart.

5. Using the polar chart pin (E in Fig.3.5) as a screwdriver, turn the X RECORDING SENSITIVITY and X RECORDING ZERO potentiometers on the right side panel of the Recorder 25 turns clockwise.

6. Press the PAPER DRIVE "Start" button on the Recorder. The paper drive mechanism should now begin to chatter.

7. Using the polar chart pin turn the X RECORDING ZERO potentiometer anticlockwise until the paper drive mechanism stops chattering and the paper is moved forward slightly to a point where the pen is directly over the required start frequency on the chart.

8. Turn the FREQUENCY TUNING knobs of the Generator or Analyzer until the digital display of the instrument indicates the required finishing frequency at the end of its selected frequency range. The paper should now move forward and stop automatically.

9. Using the polar chart pin turn the X RECORDING SENSITIVITY potentiometer anticlockwise so that the paper is moved forward to a point where the pen is directly over the required finishing frequency on the chart.

10. Turn the FREQUENCY TUNING knobs of the Generator or Analyzer so that the digital display indicates the required starting frequency once again. This will cause the recording chart to move back and stop automatically.

11. The required starting frequency line on the chart should now be immediately under the pen ready for recording. If not repeat items 7 to 11 to obtain correct synchronization. After each adjustment turn the PAPER ADJUSTMENT wheel so that the paper moves backwards a few millimetres from the required point. This will actuate the paper drive mechanism, which will automatically take up any backlash in the paper feed, moving the chart back to its original position.

For recording it is important to ensure that the PAPER SPEED selected on the Recorder is fast enough to follow the frequency sweep of the Generator or Analyzer, but is not so fast that the paper drive mechanism begins to chatter. For stable operation any PAPER SPEED setting except 10 cm/s may be used.

On completing a recording raise the pen by rotating the pen lift cam and turn the FREQUENCY TUNING knobs of the Generator or Analyzer back to the required starting frequency for a new recording. To advance the paper to the correct starting point on the next chart, lift up the spring clip above the paper drive sprockets and carefully pull the paper forward without tearing its sprocket holes.

4.3. POLAR CHART RECORDING

For polar recording the paper drive of the 2307 may be controlled remotely using the Turntable Type 3922. This is available as an accessory and may be connected to the Recorder using the control cables indicated in Fig.4.1. It is designed to rotate test objects such as microphones and loudspeakers in synchronization with polar recording charts which may be fitted to the Recorder as shown in section 3.4.3. With the "Polar Rec." PAPER DRIVE FUNCTION switch mode of the Recorder it automatically stops the rotation of the chart after completing one 0 to 360° sweep, whilst with the "X Rec." PAPER DRIVE FUNCTION switch mode it controls the rotation of the chart so that it sweeps forth and back synchronously through any preselected sweep angle between 10° and 360°. In either case start-stop functions may be selected manually either on the Recorder or on the Turntable. For correct synchronization a PAPER SPEED setting of "10 mm/s" is used.

For further information on the use of the Turntable with the Recorder, the Instruction Manual for the 3922 should be consulted.

4.4. RECORDING OF REVERBERATION TIME CURVES

Reverberation time is an important parameter in architectural acoustics work. It is defined as the time taken for a sound in a room to decay by 60 dB. Since this requires the accurate measurement of both sound level and time, the use of a Level Recorder to give a graphical display of these parameters is an obvious choice.

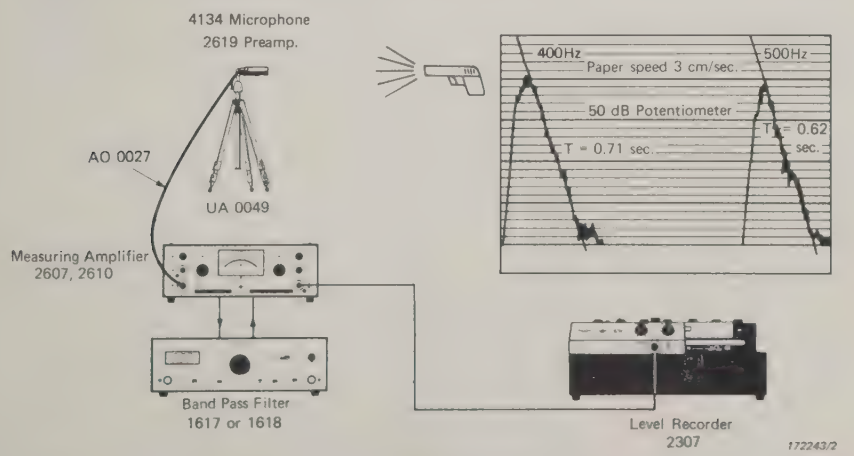


Fig.4.5. Instrument arrangement for recording of the reverberation decay of a pistol shot from which reverberation time can be determined

A typical instrument arrangement for determining the reverberation time is shown in Fig.4.5. This employs a blank firing pistol as the sound source with a half-inch microphone connected to a Measuring Amplifier plus Filter Set for measurement of the sound pressure decay of the shot over different octave and third octave frequency bands.

4.4.1. Automatic Recording

When numerous reverberation curves have to be plotted, as is necessary in investigating the acoustic properties of concert halls, theatres, cinemas and churches etc., a fully automatic recording arrangement, such as that shown in Fig.4.6 is convenient. Instead of a pistol shot this uses short bursts of octave and third octave band random noise to ex-

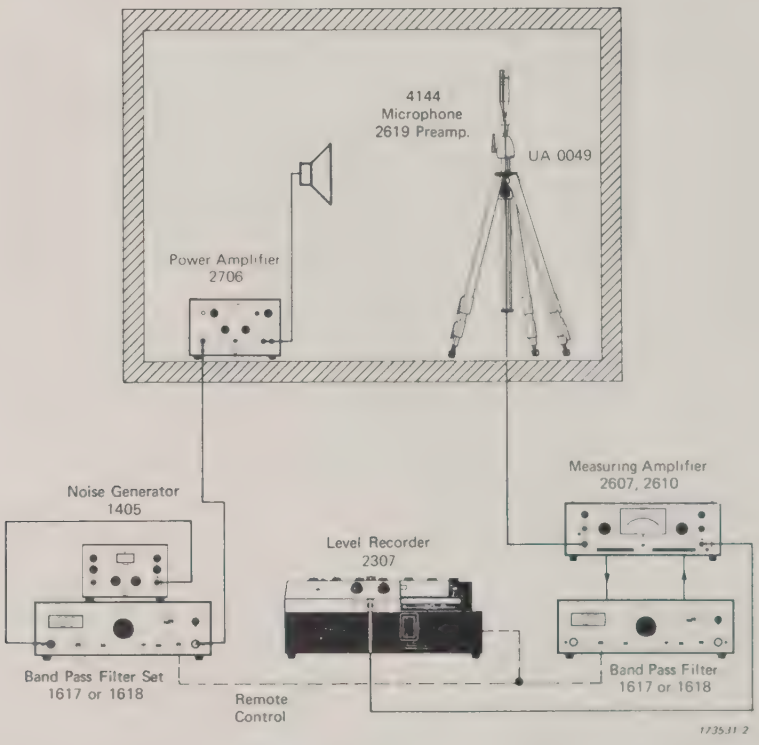


Fig.4.6. Instrument arrangement for automatic recording of reverberation curves using short burst of octave and third octave random noise as the sound source

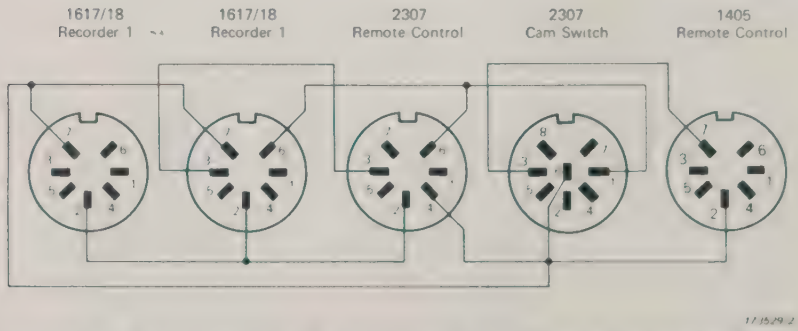


Fig.4.7 Remote control cable connections for automatic recording of octave and third octave reverberation curves using the instrument arrangement shown in Fig.4.6. The pin connections are viewed from the soldering side of the plugs

cite the measurement site. This is produced using a Loudspeaker and Power Amplifier in conjunction with a Noise Generator and Octave and Third Octave Band Pass Filter. Another Octave and Third Octave Band Pass Filter included in the receiving side of the arrangement which is the same as that employed in Fig.4.5.

For automatic operation of the instrument arrangement the remote control cable connections shown in Fig.4.7 are employed. The centre frequency of the Band Pass Filters is stepped in unison using the synchronizing pulses generated by the cam switch of the Level Recorder. With each filter step the cam switch also switches the Noise Generator on and off to produce a short burst of filtered random noise which is used to excite the measurement site. At the same time the cam switch actuates the pen control circuit of the Level Recorder automatically lowering and raising the pen for recording of each octave and third octave reverberation curve.

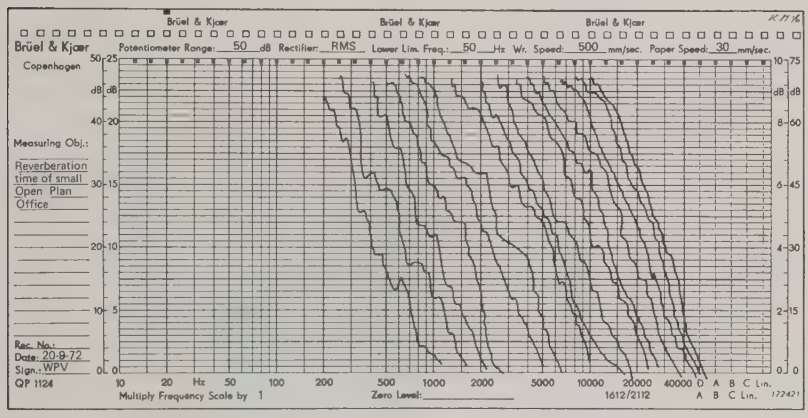


Fig.4.8. Typical example of third octave reverberation decay curves plotted using the automatic recording arrangement shown in Fig.4.6

A typical example of a series of third-octave reverberation curves recorded with the above arrangement is shown in Fig.4.8. So that these appear on one chart length a chart loop such as the one shown in Fig.4.9 is used with the Level Recorder. This is made from frequency graduated recording paper QP 1124 which for the filter centre frequency of each curve to correspond with the frequency graduations of the paper, must be precisely 495 mm long. This ensures that each curve is separated by 5 mm which on recording paper QP 1124 corresponds to a frequency spacing of one third-octave. When octave filtering is used there will be three similar curves in each octave band.

If a 10 mm interval between each third-octave reverberation curve is preferable then a loop precisely 490 mm long can be made with level graduated paper without frequency graduations. The setting up procedure for automatic recording with such a loop is similar to that for recording on a frequency graduated chart loop which is given below.

1. Connect the instrumentation as shown in Fig.4.6 and 4.7.

2. Using a wide blade screwdriver release the cover of the paper drive mechanism on the right side panel of the Level Recorder and check that DRIVE SHAFT II is fitted with cam disc OD 0059. See section 4.6.

3. Turn the DRIVE SHAFT II CAM SWITCH spindle so that the white spot on the front of the spindle is in its bottom most position ready for the cam switch to actuate the Noise Generator and pen lift facility of the Recorder. After the adjustment replace the paper drive mechanism cover.

4. Set Level Recorder controls:

POWER	"On"
PAPER DRIVE FUNCTION	"Stop"
PAPER SPEED	"1 cm/s" not "10 mm/s"
DRIVE SHAFT II SPEED	"1,2 rpm"
PEN DRIVE	"Off"

and move the pen by hand to the extreme left of its travel.

5. Set the FILTER CONTROL MODE keys on both Band Pass Filters to "Manual" and turn their FILTER SWITCH knobs so that the third-octave filter centre frequency one position before that at which recording is to commence is indicated.

6. Press and hold down the PAPER DRIVE "Start" button of the Level Recorder and release it at the precise instant the Noise Generator stops generating a noise burst.

7. Using frequency graduated recording paper QP 1124 make a chart loop precisely 495 mm long (2 chart lengths minus one sprocket pitch) as shown in Fig.4.9.

Fig.4.9. 495 mm long chart loop of frequency graduated recording paper QP 1124 for recording octave and third octave reverberation decay curves on one chart length

8. Remove the plastic paper guide clip from the paper spindles of the Level Recorder and fit the chart loop. When fitted replace the plastic paper guide clip remembering to leave approximately 0,5 mm clearance between it and the edge of the chart loop.

9. Turn the PAPER ADJUSTMENT wheel so that the chart loop is moved forward to a position where the pen is directly over the third octave marking one position higher than the third-octave filter centre frequency selected in item 5. On recording paper QP 1124 the third-octave frequency markings —■■— are marked at 5 mm intervals along the topmost line of the chart.

10. Set the FILTER CONTROL Mode keys to "Recorder-Run" and select Level Recorder functions:

PAPER DRIVE FUNCTION	"Continuous F"
PAPER SPEED	Any setting between "0,003 and 10 cm/s" compatible with the expected reverberation time of the measurement site
DRIVE SHAFT II SPEED	An "rpm" setting 1,2 times the PAPER SPEED setting, i.e. the angular displacement of the PAPER SPEED and DRIVE SHAFT II SPEED knobs should be as in item 4.
PEN DRIVE	"On"

The instrument arrangement is now set up to function automatically once the PAPER DRIVE "Start" button of the Level Recorder is pressed. Since the Level Recorder controls all external switching the PAPER DRIVE "Stop" button may be used to stop the measurement cycle at any time during recording without losing synchronization. However, do not readjust the PAPER ADJUSTMENT wheel as synchronization will be lost. On completion of recording the Band Pass Filter will stop the Level Recorder paper drive automatically. For automatic switching of the Band Pass Filters the Level Recorder PEN DRIVE switch must be set to "On".

4.4.2. Reverberation Time Protractor SC 2361

The Protractor SC 2361 is very convenient when numerous reverberation decay curves have to be measured. It has four reference quadrants which correspond with the following Range Potentiometers and PAPER SPEEDS.

Range Potentiometer	Paper Speeds
50 dB ZR 0005	10 mm/s (1 cm/s) 30 mm/s (3 cm/s)
75 dB ZR 0006	10 mm/s (1 cm/s) 30 mm/s (3 cm/s)

770404

The Protractor is designed for use with 50 mm chart widths. When reverberation curves have been recorded using the settings of one of the quadrants the Protractor may be used for reading their reverberation time. To use the Protractor proceed as follows:

1. Hold the Protractor so that its printed scale appears the correct way round.

2. Select the quadrant corresponding with the settings for measurements and place its left hand clockwise limit (heavy diagonal line) along the decay curve. Ensure that the centre of the Protractor coincides with one of the horizontal lines on the chart.

3. The horizontal line passing through the centre of the Protractor will indicate the reverberation time in seconds on the quadrant's scale of radial lines.

If used with 100 mm width charts then the indicated reverberation time will have to be multiplied by 2 to obtain the correct result. If PAPER SPEEDS other than 10 and 30 mm/s (1 and 3 cm/s) have been used then the result will have to be factored in multiples of 0,1 and 10, the former for greater PAPER SPEEDS and the latter for lesser. Fig.4.10 shows an example where a reverberation decay curve is recorded using a 50 dB Range Potentiometer and a PAPER SPEED setting of 100 mm/s (10 cm/s). In this case the Protractor indicates a reverberation time of 5,3 s which must be factored by 0,1 to obtain the correct reverberation time of 0,53 s.

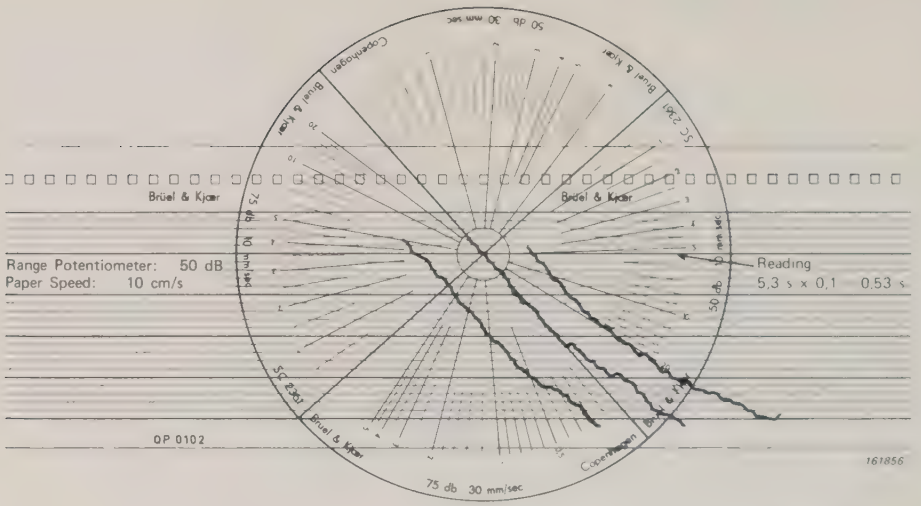


Fig.4.10. Example showing use of Protractor SC 2361 for determination of reverberation time

4.5. TWO CHANNEL MULTIPLEXED RECORDING

For comparison of time or frequency related data it is often desirable to record more than one signal on one chart length. This can be done using the Two Channel Microphone Power Supply Type 2807 in the recording arrangement. This has inputs for connection of two separate B & K condenser microphones via their associated preamplifiers and may be switched so that at any given instant only one of its microphone channels is connected for recording.

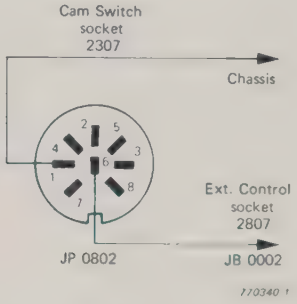


Fig.4.11. Cam switch connections for remote switching of the Two Channel Microphone Power Supply Type 2807. The connections are viewed from the soldering side of the plug

Switching of the microphone channels may be performed manually or remotely. Manual switching is via a selector switch on the instrument, whilst remote switching may be performed automatically using the cam switch of the Level Recorder. This may be connected using the cable connections shown in Fig.4.11 and functions when the screw

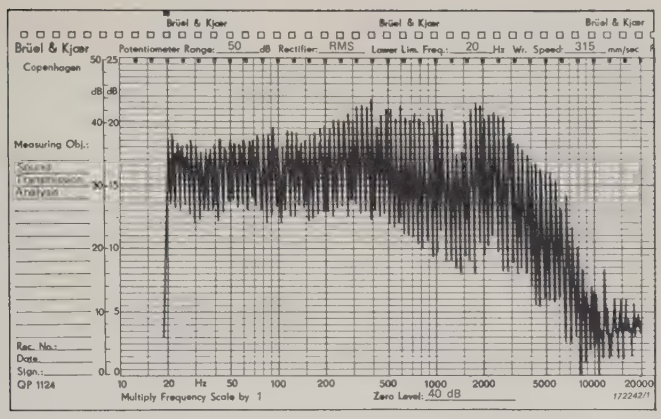

Brüel & Kjær
Potentiometer Range: 50 dB Rectifier: RMS Lower Lim. Freq.: 20 Hz Wr. Speed: 315 mm/sec
Copenhagen
Measuring Obj.:
Rec. No.:
Date
Sign.:
QP 1124
10 20 Hz 50 100 200 500 1000 2000 5000 10000 20000
Multiply Frequency Scale by 1
Zero Level: 40 dB
172242/1

Fig.4.12. Two channel multiplexed recording of sound insulation properties of wall made using the instrument arrangement shown in Fig.4.13

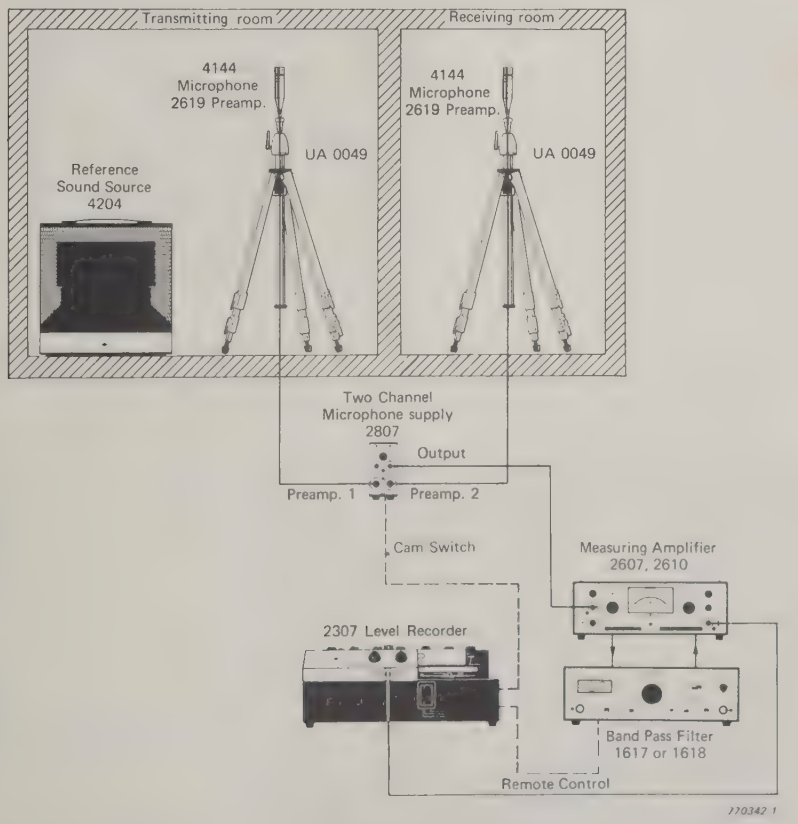


Fig.4.13. Instrument arrangement for two-channel multiplexed recording of the sound insulation properties of a wall dividing two rooms

head adjustment termed DRIVE SHAFT II CAM SWITCH of the Level Recorder is turned so that its white spot is in the 6 o'clock position. The rate at which the channels may be switched using the cam switch depends on the DRIVE SHAFT II SPEED setting and the type of cam disc fitted. See section 4.6.

A typical two-channel multiplexed recording is shown in Fig.4.12. This was recorded using the instrument arrangement shown in Fig.4.13 which is for measuring the sound insulation properties of a wall dividing two rooms. The upper part of the curve shows the sound level in the transmitting room, whilst the lower part of the curve shows the sound pressure in the receiving room.

For further information on two channel multiplexed recording the Instruction Manual for the 2807 should be consulted.

4.6. DASHED LINE RECORDING

Using the CAM SWITCH-REMOTE CONTROL socket cable connections shown in Fig.4.14, the cam switch of the 2307 may be used to operate the pen lift facility, enabling recordings to be made with a dashed instead of a continuous line. This feature is useful when a number of recordings have to be made on one chart.

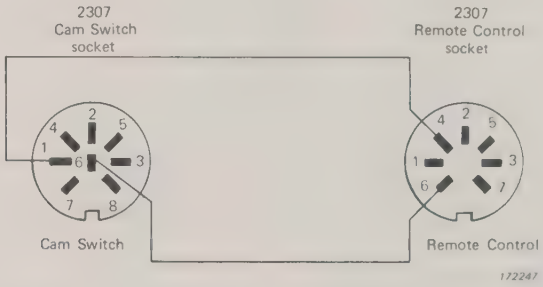


Fig.4.14. REMOTE CONTROL-CAM SWITCH socket connections for dashed line recording with the 2307. The connections are viewed from the soldering side of the plugs

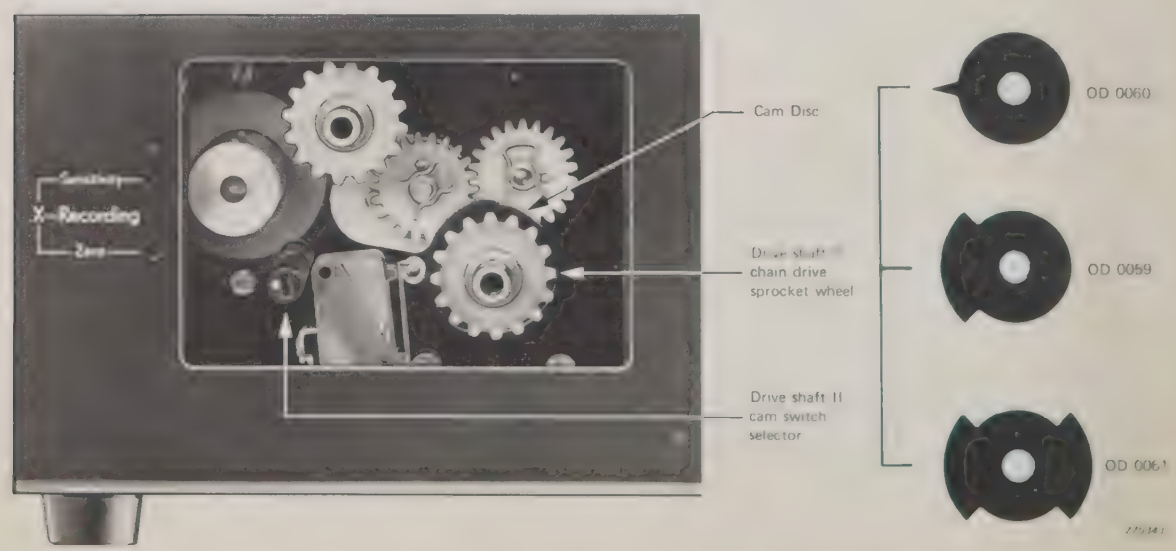


Fig.4.15. Mounting of cam discs on DRIVE SHAFT II of the 2307

The length of each dash is determined by the setting of the DRIVE SHAFT II SPEED knob and the type of cam disc fitted. These control the make and break operation of the cam switch which is actuated by the cam when the DRIVE SHAFT II-CAM SWITCH screw head adjustment on the right side panel of the Recorder is set to its 6 o'clock position. Three different cam discs are provided which may be fitted on DRIVE SHAFT II after unscrewing the sprocket wheel shown in Fig.4.15. To prevent the drive mechanism from rotating when unscrewing the wheel, the DRIVE SHAFT II SPEED knot should be set to its "0,0036" rpm position.

5. SERVICE AND REPAIR

The 2307 is designed and constructed to provide the user with many years of safe, trouble free operation. However, should a fault occur which impairs its correct function and operating safety, then it should be immediately disconnected at the mains source and be secured against unintended operation.

One type of fault which may easily be corrected is when a short circuit occurs in external cables connected to the REMOTE CONTROL socket. This will blow a 1 A slow blow protection fuse (B & K no. VF 0008) in the 32 V supply line available at the socket, preventing operation of the PAPER DRIVE "Stop" function. The fuse is located on the hinged circuit board shown in Fig.5.1 which is accessible on removing the bottom panel of the Recorder.

For repair of other types of fault, consult the Service Instruction Manual available for the 2307 or contact your local B & K service representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.

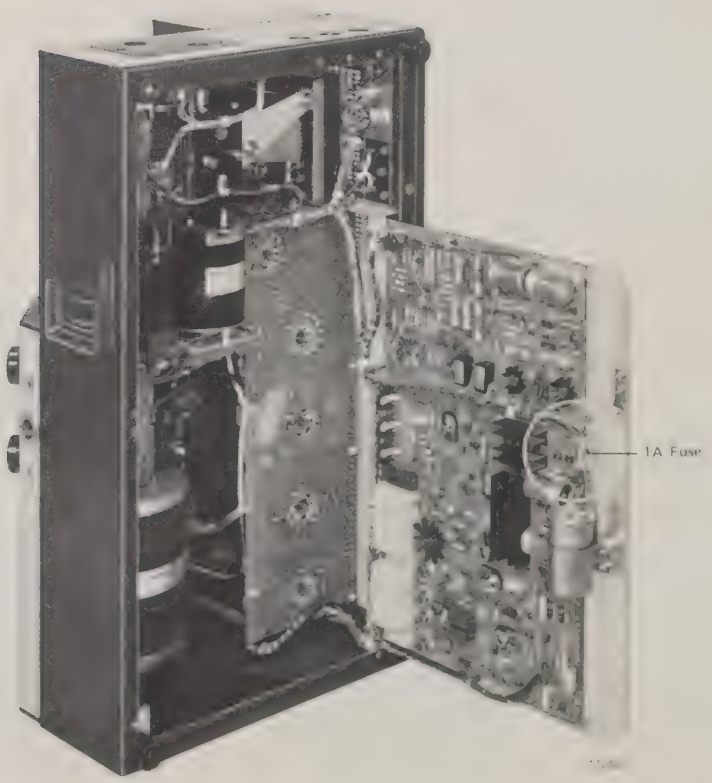
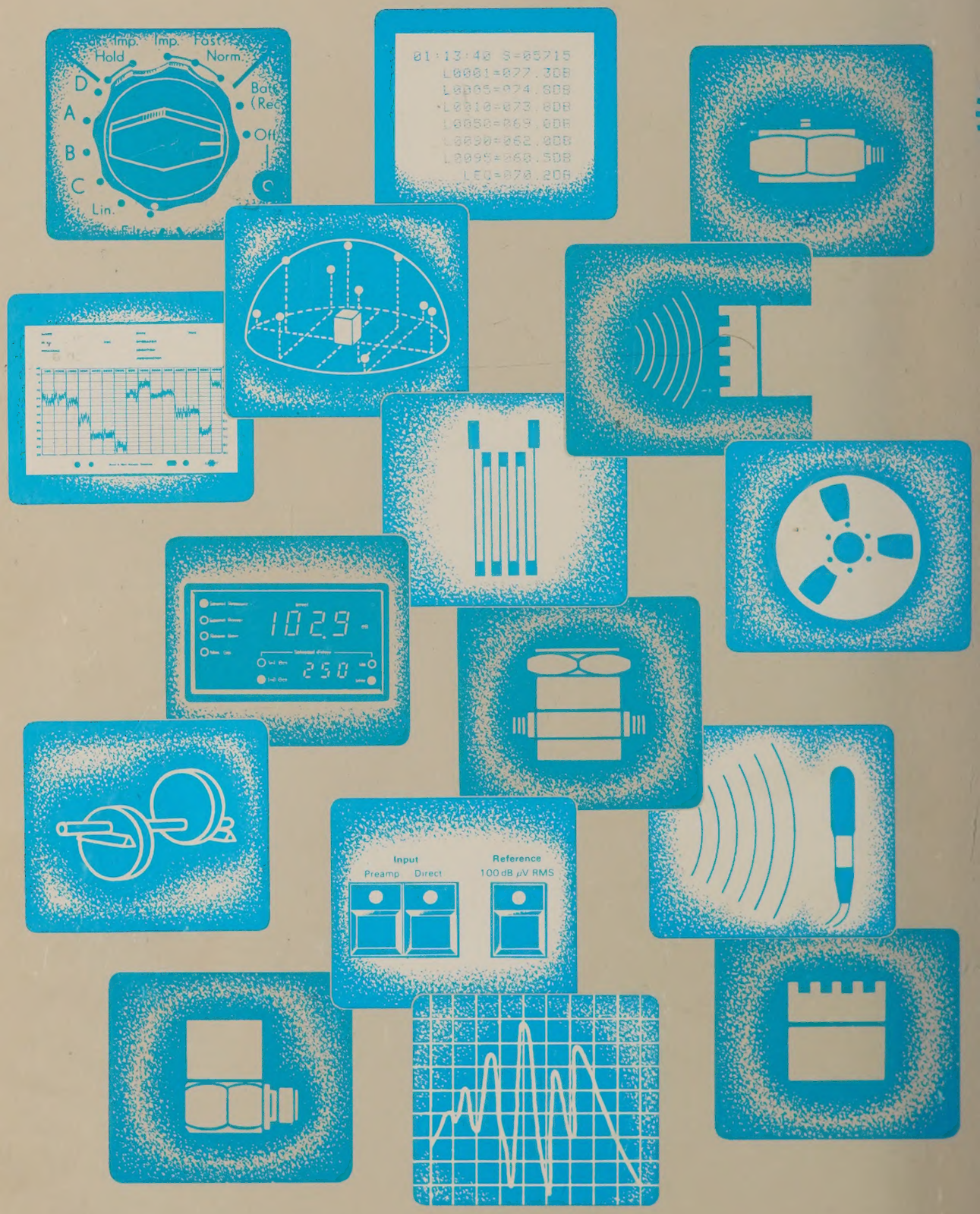


Fig.5.1. Location of 1 A fuse for the 32 V supply line available at the REMOTE CONTROL socket of the 2307



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